1986

Development of a prototype Computerized Advising System for student academic performance prediction in elective courses.

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NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

DEVELOPMENT OF A PROTOTYPE COMPUTERIZED ADVISING SYSTEM FOR STUDENT ACADEMIC PERFORMANCE PREDICTION IN ELECTIVE COURSES

by

R. Tanju Sirmen

March 1986

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CURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

a REPORT SECURITY CLASSIFICATION	1b. RESTRICTIVE MARKINGS
a. SECURITY CLASSIFICATION AUTHORITY	3 DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution is unlimited
D. DECLASSIFICATION / DOWNGRADING SCHEDULE	
PERFORMING ORGANIZATION REPORT NUMBER(S)	5 MONITORING ORGANIZATION REPORT NUMBER(S)
a. NAME OF PERFORMING ORGANIZATION: Naval Postgraduate School 6b. OFFICE SYMBOL (If applicable): Code 54	7a. NAME OF MONITORING ORGANIZATION: Naval Postgraduate School
c. ADDRESS (City, State, and ZIP Code): Monterey, California 93943-5000	7b. ADDRESS (City, State, and ZIP Code): Monterey, California 93943-5000
a NAME OF FUNDING / SPONSORING ORGANIZATION 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
c. ADDRESS (City, State, and ZIP Code)	10 SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO / PROJECT NO / TASK NO / WORK UNIT ACCESSION NO

1 TITLE (Include Security Classification)
DEVELOPMENT OF A PROTOTYPE COMPUTERIZED ADVISING SYSTEM FOR STUDENT ACADEMIC PERFORMANCE PREDICTION IN ELECTIVE COURSES

2 PERSONAL AUTHOR(S)
R. TANJU SIRMEN

3a TYPE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (Year, Month, Day)	15 PAGE COUNT
Master's Thesis	FROM _____ TO _____	1986 March 27	125

6 SUPPLEMENTARY NOTATION

7 COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	ACADEMIC PERFORMANCE PREDICTION, ACADEMIC ACHIEVEMENT, MODELING, PREDICTION, REGRESSION, MULTIPLE REGRESSION, COURSE CONTENT

9 ABSTRACT (Continue on reverse if necessary and identify by block number)

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0 DISTRIBUTION / AVAILABILITY OF ABSTRACT	21 ABSTRACT SECURITY CLASSIFICATION
XX UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	unclassified
2a NAME OF RESPONSIBLE INDIVIDUAL: T. R. Sivasankaran	22b TELEPHONE (Include Area Code): 408 646-2637 / 22c OFFICE SYMBOL: 54Sj

D FORM 1473, 84 MAR 83 APR edition may be used until exhausted
All other editions are obsolete

SECURITY CLASSIFICATION OF THIS PAGE

Approved for public release; distribution is unlimited.

Development Of A Prototype Computerized Advising System For Student Academic Performance Prediction In Elective Courses

by

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Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN INFORMATION SYSTEMS

from the

NAVAL POSTGRADUATE SCHOOL
March 1986

ABSTRACT

This thesis pertains to the area of academic performance prediction. Using multiple regression techniques with graduated students' biographical, and academic data; four predictors were successfully discovered, and the prediction model was developed. Especially course content indicated by prerequisite courses, exhibited a strong relationship to elective courses' achievement. The second important predictor was native language.

The findings of the research were also implemented through a prototype computerized system, called CAS (Computerized Advising System). This product of the study may be used to assist students in the selection of elective courses.

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I. INTRODUCTION

A. PURPOSE OF STUDY

It seems very likely that achievement in an elective course is connected with achievement in its prerequisite courses. The broad intent of this investigation was to determine whether such a connection could be scientifically demonstrated. The second aim was toward implementing a prototype computerized prediction system that carries out the results of this research. This system then could be used by students, and Academic Associates to help enhance effectiveness of students' elective course selection, via predicting their achievement. For the later purpose, some additional correlations would be searched, and identified.

At an extreme, a useful research is the "research that offers the promise of immediate benefit to someone in solving a practical problem, [which] is viewed as effort that is unlikely to generate scientific knowledge . . . . But backing off from the extreme, the need is to occupy the middle ground, that is, to design implementation projects that also yield gains in scientific knowledge and to design scientific research that also yields applied programs and products." [Ref. 1: p. 16]. Our effort was to keep staying in the 'middle ground'. All along with this research, while gaining and presenting the scientific knowledge in our particular area, we tried to develop an applicable product to solve a tangible problem.

Academic achievement has long been known to be partially predictable. A great deal of literature has indeed been produced on the subject of academic performance prediction. In our School also, some research pertaining to this area has been conducted in the past. Might or might not

they have resulted with some practical uses; our work that we are presenting here, may be a new attempt. As the primary application, we are concerned with student performance prediction in elective courses. While most of the research uses traditional psychometric measures of abilities of the student (such as aptitude tests), we also considered the content of the courses. What we mean by content of the course can be explained as follows: There is a logical relationship between prerequisite courses and elective courses in terms of content. An elective can be somehow considered as an advanced or extended version of its prerequisites; or simply logically related in terms of the subject matter dealt with in both courses. Thus, by being able to understand, or measure the performance, (or talent, or the level of interest of the student to that general subject matter), we may be able to claim that a similar performance could be expected of the student in the elective course. Besides, we offered immediate practice of our theoretical formulations.

For those who attempt to develop such a tangible product in the area of academic performance prediction, the problem is common. The basic problem, as Cattell and Butcher put forward, is "to extract from the complicated network of processes that we call education -and the even more complicated individuals for whom it is organized- some of the crucial facts and relationships that will have a general application." [Ref. 2: p.145] During the course of this presentation, we tried to conduct discussions on this problem of educational research. Our interest though, was rather directed toward elective courses, and indeed fairly simplified. Since it is possible to extend the application once the usability of the model has been validated, the scope of the work was kept limited to the students of the Computer Systems Management (367) curriculum. At the end, we implemented of our findings, as well.

B. CURRENT PROCEDURES

1. Description

In the CSM curriculum, students are supposed to decide on their emphasis area. This selection takes place about the end of second, or third quarter.

Currently, students are assigned to an Academic Associate who advise, and identify the best set of courses for the students. In addition to the School policy guidelines, the Academic Associate uses his experience, and judgement in discharging this function.

In order to perform a proper evaluation, we should understand the emphasis area's features and requirements, and the student's abilities relating to that emphasis area. To our knowledge, advisors being the first and the formal way, there are four viable ways of acquiring an idea of an elective course. They are:

a. Consulting the Academic Associate;

b. Consulting the School Catalog to read brief course descriptions;

c. Asking for the Curriculum Officer's guidance;

d. And finally, which is not formal but available, asking for predecessor students' opinions.

2. Problem of Concern

It is assumed that students will have gained sufficient understanding of all of the alternatives. To us, it is too optimistic to expect them to make an effective decision by themselves. This is especially true for those who have no prior background in the area. Thus, it is essential to equip students with recommendations, to enhance the selection quality, and to increase the student-course match. Unfortunately, none of the current methods is adequate.

Typically, the Academic Associates do not have access to the historical data about the performance of the students advised in the past. Their recommendations tend to be general, and are not to be specific to any particular

student's abilities, or interests. It is not possible, either, to personally know all of the students.

Neither the remaining three sources of information can provide scientifically based directions. Descriptions in the NPS Catalog are so digested, and only list the main topics to be covered during the course. More than likely, students have not the sufficient knowledge to assimilate most of these terminological terms.

Curriculum officers are always willing to help; however, they may or may not know the match of all of the courses' contents to a particular student's background. Besides, this is not their primary task. There is not much to say about the predecessor students. Their opinions, reflecting their own experiences in the courses, are quite subjective.

As a consequence, majority of the students end up with at least a few course changes, or even worse, switches in emphasis areas. That eventually decreases the quality of the education, while concurrently reducing the student-course match, and student satisfaction.

C. BENEFITS OF STUDY

As mentioned earlier, advisors do not access previously advised students' historical performance data. However, such a feedback might be extremely useful, since the influence of some of the important variables have proven significant. The predictive model refined in this study relates specified variables of a student's background to current academic performance. Hence, it may fill the gap shown in the discussions above. The basic product is the prototype of the Computerized Advising System (CAS). By using this system, a student could obtain the prediction of his/her performance in any elective course. Since the CAS utilizes the student's own data, it gives particular predictions for that student.

Thereafter, the student would be able to compare, and evaluate the most suitable combination of courses for him/her self.

Uniting the predictions of CAS with the presently-used advising procedures, would provide better appreciation of available options, for both the Academic Associate, and the students. This could eventually help improve educational quality.

II. PRIOR RESEARCH

A. DISCUSSION

Whereby a complete summary of literature is beyond our scope, we would like to provide some relevant insights and discuss common problems of this discipline, before proceeding further. "As traditionally used, the term 'academic performance' refers to some method of expressing a student's scholastic standing. Usually this is a grade for a course, an average for a group of courses in a subject area, or an average for all courses expressed on a quantitative scale." [Ref. 3: p. 18]. Since grade, or grade point average is the most vastly used criterion, a majority of the studies try to discover those factors that will enable us to predict academic performance. Lavin indicates that, "This research for predictive factors has focused primarily upon various characteristics of the student, such as his aptitudes, his personality traits, and the like." [Ref. 3: p. 19].

Lavin finds three basic correlates: "These are ability, sex, and socioeconomic status. We call these 'basic' correlates not because they are theoretically more significant than other variables, but because they are related to performance more consistently." [Ref. 3: p. 43].

The relationship of personal abilities to academic performance is pretty well proven, and the studies in this area are no longer concerned with demonstration of this finding. Instead, they try to investigate the correlation of performance with control of the ability. For that purpose, they examine 'high and low achievers', and 'over- and under-achievers.' "It is incorrect to consider high and low achievement to be synonymous with over- and under-achievement. The distinction between

the concepts is that high and low achievement are defined in terms of an absolute standard of performance, while over- and under-achievement involve the discrepancy between predicted and actual performance." [Ref. 3: p. 24].

Apparently the academic performance term and its prediction, do include by definition both 'student', and 'courses' dimensions. However, despite this fact, it is observed that in the majority of the research, the major effort has been to discover the student side. As mentioned above by Lavin's words, research has primarily focused on exploring the aptitudes, personality factors, and so, of the students. Although we admit that those factors' predictive power is commonly accepted, and are legitimate, we also suggest that the content of the related courses has a significant influence over the performance, so it should be considered. In our case, for example, the sample group exhibits a good homogeneity in the personality traits. (This point is further discussed in the next chapter.) Therefore, they are not very usable from a statistical standpoint. We also believe that there may be similar instances in other universities. Yet, the content of the course still provides the needed predictive power. For our case, the content of a course is discernible from its prerequisite courses. If the content of a course somehow relates to a student's performance, then this student's achievement (which is expressed by his/her grades) in an elective's prerequisites should, and could, suggest his/her achievement in that elective.

The results of one particular research in the past, are very close to our suggestions. Sheldon, in his paper, criticizes the traditionally-used psychometric devices in the prediction of an individual's academic performance. After pinpointing some ignored elements of traditional research, he indicates a more appropriate alternative. He

concludes that, "course, and curricular admission criteria to be related as closely as possible to course content, rather than to a construct called academic aptitude . . . . Such an approach can be implemented through counseling and encouraging students to attempt only those courses for which they have a high probability of success." [Ref. 4] This is consistent with what we are proposing, and what we tried to implement in this research.

B. COMMON PROBLEMS

As will be mentioned in the next chapter in more detail, a modified version of the 'Concurrent Validity Model' is used in this thesis. This model puts restrictions on the range (or size) of sampling. Another alternative was to use the more traditional "Follow-up Method". Stated by McKenna, with the Follow-up Method, a prediction model would be developed with the present set of people, and applied to new enrollees to validate the model, after a sufficient time has elapsed. [Ref. 5] That effort would obviously take too long. Thus we took advantage of the time savings that the Concurrent Validity Model offers.

Much more important than this occasional situation, research in this area suffers from some more general problems. It is commonly experienced that relationships between predictors and performance criteria are generally not very strong. "Researchers usually view this as an indicator of: (1) failure to isolate enough of the right variables, and/or (2) measurement error in the predictors. Low correlations might also be due to uncontrolled sources of variation in grades themselves.

"Second, teachers use different criteria in assigning grades . . . . Since not all students have the same instructor, and since instructors vary in terms of

the criteria they use, as well as the importance they assign to each criterion, it is clear that there is also considerable uncontrolled variation here. Moreover, students differ in their ability to perform well in different areas; some may express themselves better in writing than orally, and some perform better on essay than on objective examinations. In addition, there is the question of some teachers are 'harder ' markers than others. Furthermore, some evidence suggests that implicit, subjective criteria are involved in teachers' grading practices . . . . [Because of these,] student grades lack a high degree of comparability." [Ref. 3: pp. 19, 20].

As with all the other social relationships, a grade is a function of the interaction between student and teacher. All these comments suggest that it is worthwhile to consider the instructors as another, and very important variable. However, it has some practical drawbacks. Trying to assign grades to the instructors (even it sounds very joyful!) might involve some degree of subjectivity.

Studying such a social interaction brings to light that all of these subjective factors pose even more problems due to the difficulty in defining and measuring them reliably. We believe that any investigation of human activities can, unfortunately, never be complete. Yet, attention to these problems enriches our understanding of academic performance prediction, and thus helps us to enhance our ability to predict better.

III. RESEARCH METHODOLOGY

A. METHODOLOGY

1. Description

This research has been administered through three basic stages. These are: model construction and statistical analysis, refinement of the model, and implementation and system validation. In actuality, none of these stages is distinct, or separated from one another; and they altogether constitute the entire process.

The technique we employed is known as the "Concurrent Validity Model", or the "Present Employee Method", as expressed by Korman. [Ref. 6] The methodology for the system development from the broad perspective was as follows: The predictors were developed using a group of graduated students' biographical, and academic data. We utilized these data to identify the important factors that are related to the academic achievement of the students; therefore they are the key indicators of future performance. Multiple regression techniques were used in discovering associations which would effectively explain the above relationships. Computer programs and data bases that would manipulate the model, were developed. Finally, the system was cross-validated with another group of graduates, against a predetermined level of confidence.

Following is the detailed presentation of these stages.

2. Major Activities

The research was started by determining the objective. The present system was analyzed, and the problem of concern was explored. Literature reviews led us to deciding on the methodology and techniques to be used. The level of confidence which was to be sought from the system was

determined. After that, there were the following activities:

a. Model construction and statistical Analysis

1) At the beginning of this stage, the sample group was selected;

2) The criterion was named;

3) The primitive of the model was constructed;

4) Possible variables correlating with the criterion were indicated;

5) Data from the sample group were collected, and edited for the computer;

6) Correlation analyses were made;

7) Results were interpreted, and insignificant variables were eliminated;

8) Finally, regression analyses were run on the remaining variables.

b. Model refinement

1) After the regression analyses,results of the prior stage t-tests were done to identify the statistically significant variables;

2) These significant variables were taken as basic predictors, and the primary regression equation was developed, and applied to the preliminary model;

3) Validation of the model was checked by F-tests;

4) Refinements were made to the coefficients of predictors, and the model refinement was completed.

c. Implementation and System Validation

1) The data base of CAS was built and edited;

2) Computer programs, which would manipulate the database, and would implement the prediction model, were developed;

3) The cross-validation sample group was chosen, and their data were collected;

4) Correlations among the validation group were cross-validated with the correlations among the original group;

5) CAS was run with the validation sample group's data;

6) CAS's outcomes were evaluated, and tested against the predetermined confidence level;

7) Demonstration of the system's validity concluded the job.

B. SAMPLE SELECTION

Due to the very complex nature of things, no one can completely identify all the aspects, or relations, of any phenomenon. Within infinite interrelations and interactions of an open system with its environment, there inevitably are some missing factors. No matter how thoroughly elaborated, those factors would somehow affect the correctness of results to different extents.

Integrity of the selected sample might help minimize the bad influences of potentially missing factors. If we can preserve the integrity of the data sample, all members are likely to bear similar unknown effects. Therefore they would be comparable. In other words, they should have been cooked in fairly similar pots, by fairly similar cooks, so that they could be legitimate to compare.

In contrast with the integrity requirement, the sample group should be general. An overriding principle for every research is that the results should be capable of generalization. This implies, "the sample tested must be typical or representative of the wider group which one hopes to generalize." [Ref. 2: p.146]. For instance, if the project undertaken is to, say, determine average income level for Monterey Peninsula, the data sample should be selected neither from only Pebble Beach (the richest), nor from only Seaside (the poorest).

Using these principles, we have chosen our sample from students who graduated at the same time from same curriculum. We also wanted them to be recent graduates, so that we would be able to analyze them easily. The September 1985 graduates of the Computer Systems Management Curriculum have been chosen as our sample set. This was the most recent data available to us and there exists among them the desired integrity. When investigated, there was no indication of any outstanding people in any terms (eg. high- or

low-achievers), nor was there any extraordinary situation recorded during their period in the curriculum.

Our sample curriculum is not distinguished from other curricula of the School. In some other curricula, the majority of the courses may be mathematics, or a similar kind of universal language. In these curricula, the language factor, for instance, might not have the same influence on the achievement, as technical background. Conversely, success in another curriculum may be almost totally dependent on language abilities. However, our curriculum (CSM) requires a mixture of those abilities, but does not rely on any of them to an extreme. It sounds reasonable to claim that CSM can be considered representative of the other curricula of the School.

We analyzed 154 elective courses and 564 prerequisite courses, and the academic, biographical, and background data of 34 people as the original sample. The data itself, along with the details of the statistical analysis, are discussed in the fourth chapter. Then the developed system (or model) was cross-validated by testing against the data of the same curriculum's (CSM) previous graduates. Included in the validation tests, were data for 32 elective, and 155 prerequisite courses' grades, and data of 9 people among March 1985 graduates were used.

C. CRITERION

As a means to express students' academic standing, "grade" is the primary measurement. This is because it is the only tangible output of an education. As it is usually the main criteria in the traditional academic performance prediction effort, the grade concept is "two headed", because it is interpreted by the students from one perspective, and given by the instructors from another. (It is generally assumed by students that poor grades are not deserved by them, but are given by

instructors.) In addition, if we account for the "relationship" between the student and the instructor as a third dimension, the situation becomes more complicated. Do the grades really reflect students' success? How fairly can one person grade another person's effort? With how many important factors is performance correlated? Such questions remain un-answered, showing that the criterion and the predictors are very uncontrollable, and difficult to identify.

Although there has been some doubt about its representative power, "the most frequently used criterion is Graduate Grade Point Average (GGPA), probably because it is an easy one to use . . . . Other criteria for graduate students performance include: (1) success or failure in completing an academic program, eg. MS. or Ph.D.; (2) faculty ratings of students other than by grades (cf. Hilton, Kendall, and Sprecher, 1970); and (3) self ratings (cf. Hackman, et al., 1970)" [Ref. 7: p.1, 2].

In this case also, the grade point averages of students in their respective elective courses were chosen as the criterion. In this connection, a student's grade in an elective expresses his achievement in that course. This is valid for prerequisite courses, as well. Elective course grade point average is represented by 'EAV' during the statistical analysis.

D. VARIABLES

The predictor data, estimated in the preliminary analysis, were not always in the desired form. In some cases, they were not available at all. Therefore, as the practice imposes, it is very likely that it will be necessary to re-estimate the potential correlations among the available data. At this point, there are at least two important problems to ponder. "First, many predictors that have similar labels may, in fact, be measuring different

content . . . . The second difficulty is the obverse of this: some predictive factors that are defined differently on the conceptual level may not actually be independent of one another." [Ref. 3: p. 34].

Much of the inconsistency in the findings encountered before might be due to the first problem above, which is the actual dissimilarity of similar labels. That problem suggests that we work toward better standardization in the use of predictor measures.

Regarding the second problem, there may be the promise of a large number of predictors which is never realized. To overcome that the variables which are inter-correlated should be eliminated, or classified together.

The variables examined in this study were investigated according to the above considerations. The variables which exhibited one of these problems were treated accordingly in order to not experience similar inconsistencies. A description of the precautions which were taken can be found in the fourth chapter under a related title. For now it will be sufficient to present the variables in general terms in Table 1 below. This table consists of both un-correlated variables and discovered predictors. The column 'representation' indicates how non-numerical items were represented. Variable symbols will be used in this text in place of the variables.

TABLE 1

VARIABLES OF ANALYSIS

VARIABLE	SYMBOL	REPRESENTATION	COMMENTS
elective courses grade point average	EAV	direct	criterion
prerequisite courses grade point average	PAV	direct	
country	CTY	countries were numericaly coded	USA was 0
language	LNG	0 for english 1 for nonenglish	if English is native lng, coded 0
sex	SEX	0 for male 1 for female	
age	AGE	direct	age = graduated year-birth year
marital status	MRT	0 for married 1 for single	entrance status was assumed unchanged
number of children	CHLD	direct	
location	LOC	regions of the area were coded	location of residence
service	SVC	military service was coded	Navy was 0
years of service	YEAR	direct	YEAR = graduation - service entrance year
rank	RNK	ranks enumerated hierarchically	Captain was the limit
more than one degree	MOR	0 for no 1 for yes	prior to the school
highest degree	HIDG	academic degrees were enumerated hierarchically	from none (0) to Ph.D (7) (3) for unknown
whether degre related to computr/mngmt	RLT	0 not related 2 for related to both of them	1 for : related to either computers, or management
refresher course taken	RFS	0 for not taken 2 for taken	1 for unknown
inter-curriculum trnsfer	TRS	0 for no 1 for yes	some students had switched their curriculum to CSM

E. ASSUMPTIONS

Assumptions are crucial in any research, and are of particular significance in the area of 'predictor analysis' or 'predictor modeling'. In order to make the analysis possible, we needed to eliminate unimportant but distracting parts of the data, and make the analysis sufficiently stable to focus on the main interest.

"The achievement is a function of the environment and its characteristics . . . and of the individual characteristics of the particular person." [Ref. 2: p. 145] The environmental characteristics are assumed constant so the researcher can concentrate on individual differences among the sample population. Hence, the prediction of achievement was be in terms of psychological, not of sociological factors; that is, factors of ability, personality, and motivation.

In this case, achievement in the prerequisite courses is suggested to be the major predictor. Using it in our model in company with the other factors, will enable us to predict the performance in the elective courses. Also we assumed the environmental conditions were constant for a period of 3-6 quarters. (This 3-6 quarter time period was the period between taking the prerequisites and choosing electives.) Unless some extraordinary events happen, this assumption seems reasonable.

For predicting an elective, only the related prerequisites' course grades were used. Two additional, and equally important, assumptions were made. First, we assumed that when prerequisites were determined for a course, they were strongly related to the content of the course. This is important because, prerequisite course grade point average is the the basic predictor of success in the model. In other words, we believed that, say a 'Chinese Painting' course had not been made a prerequisite for an 'Advanced Calculus'.

The second additional assumption concerns instructors. As we mentioned before, an instructor has a great impact on the students' motivation for the course. As in all the other areas, the motivation factor has proven its important role in the students' academic performance. Furthermore, once the grades are counted as the basic measurement of academic success, the differences between instructors' grading policies assume even more importance. Nevertheless, since there was no indication of significant variations in their policies, all the instructors were assumed to be fairly equal in the way they motivate the students, as well as the way they grade. Additionally, as pointed out earlier, the probable subjectivity that would be involved in grading instructors, might make that attempt unmeaningful.

"Personality factors would seem to account for some of the variance unexplained by academic aptitude measures and undergraduate grades. One variable would be the need for achievement." [Ref. 7: p.14]. A number of such motivation-oriented reasons can be related to explain some under, or over achievements. In this case, however, it was not necessary to deal with such considerations, since the population of our concern is somewhat homogeneous, and small enough to identify and discard those (if any) outhers in the sample.

"In many studies concerning the prediction of academic performance, the relationship between a predictor variable and the criterion is assessed by means of correlation analysis. In almost all of these studies, the correlation method assumes linear relationships; that is, they assume that unit increases in the predictor variable will be followed by unit increases (or decreases in the case of negative relationships) in the criterion, and that this will occur along the entire distribution of scores." [Ref. 3: p. 38]. Linearity is not always the case obviously. However, it may be the best way to start, since, otherwise, the entire process

would become too complex at the beginning. Not only because it is the traditional way, but also because there was no evidence or reason to believe in curvilinearity, the linear relationship of predictors and the criteria were assumed. Yet, if the plots of variables indicated, or if the model failed to predict at a certain level of confidence, it was always possible to go back and try other kinds of approaches.

IV. DEVELOPMENT OF MODEL

A. GENERAL DISCUSSION

Before evaluating the results of our analysis, we would like to quote a few words regarding the usual low-correlations problem in the area of academic performance prediction. Senger J., and Elster R. write the following in their investigation of the research in this area. "Choosing albeit arbitrarily, a correlation coefficient value of .35 as indicating marginal predictive respectability we find in Table I that less than half of the 42 GRE-V (Graduate Record Examination-Verbal) coefficients equal or exceed that value..The GRE-Q (GRE-Quantitative) is even less inspiring. Ten of the 43 coefficients exceed .35, and four are above .50. The same results exist for the GRE-Advanced data . . . . Perhaps it is the criterion, graduate grades, that is responsible for the relatively low correlations. Tables II and III present alternative criteria - but with the same kind of indifferent results . . . again at a very modest level. Of the 53 correlations . . . only one exceeds .35." [Ref. 7: p.4-10]

So naturally, the authors concluded that, "As a result, the low correlations can almost be expected." [Ref. 7: p.11]

It would seem that standard measures of motivation and interest (for detailed information, see [Refs. 8,9: pp. 218, 237]) should be worthwhile supplemental predictors; unfortunately, studies to date do not support this expectation . . . . The investigators using these instruments show their predictive power is usually low. [Ref. 7: p. 18]

"Examination of the accompanying tables of correlations between intellectual and other measures and criteria of graduate student performance does not encourage one to increase his faith in the validity of the popular predictors used singly. It must be stated, however . . . validities of these measures may be better than the typical study makes them appear.

The phenomenon of low predictor - criterion relationships may not be restricted to academic performance . . . . Difficulties in predicting performance appear to be universal." [Ref. 7: p.17]

Any kind of predictions dealing with some open systems, such as human beings and their activities, will always bear some degree of unpredictability.

After all these discussions, we could ask that, is it all worth the bother, as the authors of these words did. If the predictive power of such a work is that low, should it be quited. Although we did agree on emphasizing the low-correlations issue, the necessity of predictions of human activities persist, that they still are of value. Also the very same authors admitted that even predictors with low validities can be expected to be useful in decision making. [Ref. 7: p. 19]

B. MODEL

Correlation analysis would lead to discovering how much association there is between the variables. However, a regression equation is still needed that could be used to predict the criterion from the predictor variables.

Since linearity was assumed for the relationships of the variables to the criterion, the prediction model would be something like:

$$y = B0 + B1*X1 + B2*X2 + B3*X3 + B4*X4 + \ldots \quad (4.1)$$
$$\ldots + Bi*Xi + \ldots + Bk*Xk$$

where 'y' is the dependent variable (criterion) which is to be predicted, X's are the independent known variables (predictors) on which the predictions are to be based, and B's are numerical weighting constants that are to be determined from the observed data.

The above equation is the primitive form of the model. During the model refinements, the objective is to be to find numerical correspondances of the weighting constants (B's), in order to derive the best descriptive model of the observed data.

The null hypothesis (Ho) in this case is to be, Bi = 0, which in turn implies that that Xi variable cannot be placed in the prediction model, because of the 0 value of its coefficient. In other words, if the null hypothesis proves correct, then it is assumed that there is no statistically satisfactory predictive power of that variable Xi in the model. The alternative hypothesis (Ha) is therefore to be : Bi not = 0 (meaning that some of the variables have statistically significant usability in prediction.) To test the null hypothesis, t-tests are used. The general formula is :

ti = (Bi - (hypothesized value)) / (SD. of Bi) (4.2)

SD is the estimated standard deviation of Bi. [Ref. 10: p. 162]. This ratio exhibits a t-distribution with n-(number of parameters in equation) degrees of freedom. [Ref. 10: p. 170]. In this case, the hypothesized value was 0. Therefore the general formula of the t-tests was to be :

ti = Bi / (SD. of Bi) (4.3)

The results of the t-tests for predictor development, and the model validation are presented below.

C. RESULTS

1. Correlation Analysis

Although the common low-correlations problem suggests that we should not be very optimistic, our results were somewhat better than indicated above. The main variable PAV showed 0.698 correlation with the criterion EAV. The corresponding plot in Figure.1 also exhibits the correlation.

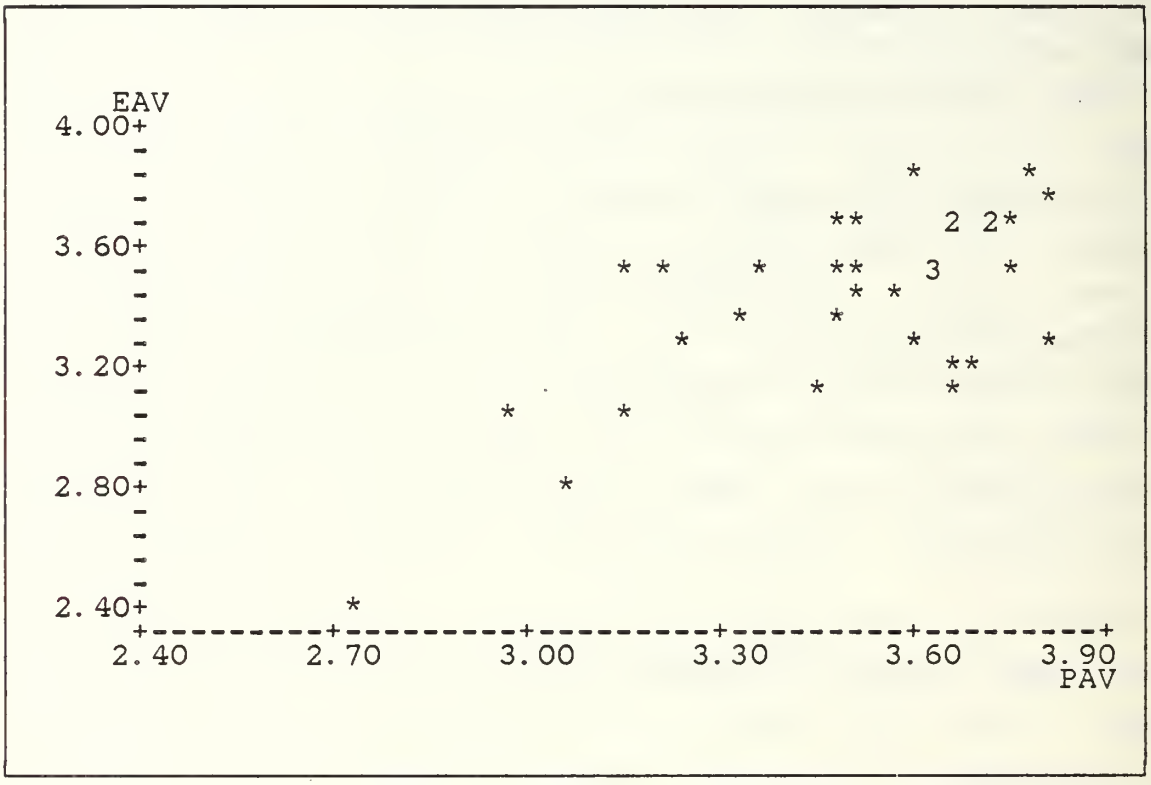

Figure 4.1 Plot of PAV vs EAV

Also two additional variables among the total of 17 were correlated over 0.50, while the others confirmed the common problem with low values. Only three of the 17 variables had correlation coefficients over 0.35 (PAV 0.698, CTY 0.508, and LNG 0.550). The complete output of the results can be seen in Appendix A.

When examined, the variables in Table 2 exhibited considerable inter-correlations. These inter-correlating variables were the representation of similar or related factors with different labels. Therefore, they were not used together as predictors in the model. They functioned, however, to cross-check each variable's indication of correlation. If one of them was correlated with the criterion, the other one ought to show a similar correlation. After that analysis, one of each pair was eliminated in the regression analysis.

TABLE 2

INTER-CORRELATIONS AMONG VARIABLES

Variables	Coeff.	Interpretation
MOR & HIDG	0.560	If the person has more than one degree, he is likely to have a higher degree
MRT & CHLD	0.831	married students are likely to have child
CTY & LNG	0.930	native language and country correlated
AGE & YEAR	0.601	age and years of service correlated

2. Predictor Development

The predictor variables were identified at the end of this step. Multiple regressions up to 9 variables were developed using the MINITAB statistics package on the IBM 3033 mainframe. [Ref. 10] The complete output is presented in Appendix A, under the corresponding title.

A confidence level of 0.90 was determined as an objective to be sought throughout this research. Thus, the predictions of the system were to be valid only if it could satisfy the demanded 90 % confidence level.

With respect to this 90 % confidence figure, the T-Ratios of the coefficients were tested to validate the hypothesis. (Which is: Ho : Bi = 0 vs. Ha : Bi not = 0).

After the t-tests, four variables survived as statistically significant. These are: PAV, LNG, SEX, and RFS. Interpretation of these variables are presented in Table.3. If the model could be validated, then these four variables were to serve as predictors to predict the criterion.

TABLE 3

INTERPRETATION OF PREDICTOR VARIABLES

Predictor	Interpretation
PAV Grade point average in prerequisites	Since the prerequisite courses refer to elective's content, success in prerequisites promises success in that elective
LNG (Language)	If english is student's native language, then a better performance is expected
SEX (Sex)	Female students exhibited better performances than males
RFS (Refresher)	If the student was not required to take refresher, he probably has the necessary background

3. Model Refinement

The multiple regression equation, which was constructed from the weighting factors for the four variables above, and the necessary constant was denoted as EQ1.

$$EQ1: y = 0.8432 + 0.7853\,(x1) - 0.28768\,(x2) + 0.15181\,(x3) - 0.06427\,(x4) \qquad (4.4)$$

The occurrence of the negatively weighted variables in EQ1 was due completely to the arbitrary code representation of these non-numerical variables. The basic formula EQ1 was subjected to F-Tests for model validation.

For consistency, the maximum prediction outcome of the model is to be 4.00. Since the upper and lower limits of EAVs among the sample data were naturally different from,

respectively, 4.00 and 0.00, a minor correction to EQ1 was required. After the addition of the correction factor, the obtained formula EQ2 was the actual model used for prediction.

$$EQ2 : EAV = 0.70699 + 0.7853\,(PAV) - 0.28768\,(LNG) + 0.15181\,(SEX) - 0.06427\,(RFS) \quad (4.5)$$

This model was subjected to the system validation tests, which are presented in the following chapter.

V. IMPLEMENTATION AND SYSTEM VALIDATION

The presentation of existing correlations and development of the prediction model based on the identified predictors concludes the first part of this thesis. The second objective was to implement the findings of the first stage. For this purpose, the Computerized Advising System (CAS) was developed. In this chapter a brief description of the CAS is made, and the system validation tests are discussed.

A. COMPUTERIZED ADVISING SYSTEM

1. General Definitions

The broad idea was to support the elective course selection process by providing predictions of performances for various elective courses. This is fulfilled through the use of the prediction model EQ2 implemented in computer programs. More specifically the CAS interactively obtains the values of the predictor variables from the user, assigns them to the model, and comes up with the prediction. It utilizes a pre-established data base for determining the prerequisites of an elective course.

The courses offered in the CSM curriculum are not static. Both the electives themselves, and their prerequisites are subject to change. Some new courses of both types may be added , or some old ones may be removed from the program through time. Or, there may be changes in the prerequisite assignments to the electives. For this reason, a database maintenance capability is provided with the system.

Validations, or taking courses which are equivalent to prerequisites are permitted . So, how should the data be interpreted if a student has not taken a prerequisite for

some reason? With respect to the findings, has that person missed all the benefits of taking that prerequisite? Should he be graded F? In most of the cases, however, the particular student either had a respectable background, or passed the validation exam (if there was one) with a good score. Should he , therefore , be graded A? Neither of these sound acceptable. In order to avoid confusion, it was decided to not count those courses which have not been taken. Hence, to predict the student's performance, only the 'taken' prerequisites' grade point average, (and the other factors, of course) was used, but nothing more. If the person asking for prediction has taken none of the prerequisites, it is preferred to give him a warning telling that the system cannot predict with that few data, and he is invited to try another one.

On the other hand, there are some courses which do not require prerequisites. In such instances, the remaining factors (ie. LNG, SEX, and RFS) were used, and to be reasonable, assigned to the prerequisites an average of 3.5.

2. Mechanics Of The System

a. General Scheme

The system has two main branches: 1) Maintain branch, and 2) Prediction branch.

1) Maintain Branch: This branch provides the opportunity for updating the data base according to the changes in the courses. It has three sub-branches; namely: a)Insert an elective, b)Delete an elective, and c)Edit an elective. Hence, it is possible to add (or insert) new elective courses to, or remove (or delete), old elective courses from the data base, with its prerequisites. In addition, any changes to the content of an elective (such as the quarter it is taught, or credit-hours) can be edited into the course. In order to prevent unauthorized modifications, a password is required for the user to be accepted into this branch.

2) Prediction Branch: Users are normally involved with this branch. Here, the predictor factors are obtained, and the prediction is produced. The general scenario is as follows: First the predictors are requested, and factored. Then a list of

the elective courses is provided to the user to choose from. Grades from the prerequisites of the chosen elective are obtained, and evaluated. Finally the predicted values for QPR, grade, and success percentage are treated. The CAS allows multiple predictions.

b. Data Base and Programs

The CAS manipulates four different data base relations, and their corresponding indices. These are ELECTIVE, PREREQ, ELETOPRE, and 2NDSET. All of these relations and their indices, and the programs are created using a microcomputer database package, called dBASE-II.[1] The CAS itself is intended to be used in microcomputers.

The ELECTIVE relation holds the basic data of the elective courses. The same data for the prerequisites reside in the PREREQ relation. ELETOPRE relates the electives to their prerequisites. In some cases, a course's prerequisites are given as: 'A or B; or A and B, or C and D, etc.'. The 2NDSET relation facilitates such instances, which are indicated in the ORFLAG attribute of the ELECTIVE relation. The 2NDSET was constructed to prevent data redundancy. The structure of the database relations shown in Figure 5.1.

There are a total of 15 programs constituting the CAS. Six of them are for the maintain branch, five for the prediction branch, and four in common. The listings of the programs are presented in Appendix B.

B. SYSTEM VALIDATION

1. Validation Process

For system validation, 32 elective, and 155 prerequisite course grades, and other predictor data of 9 people were examined. The test sample was randomly chosen among the previous (March 1985) graduates of the same (CSM) curriculum.

-dBASE-II is the trademark of Ashton-Tate Corp.

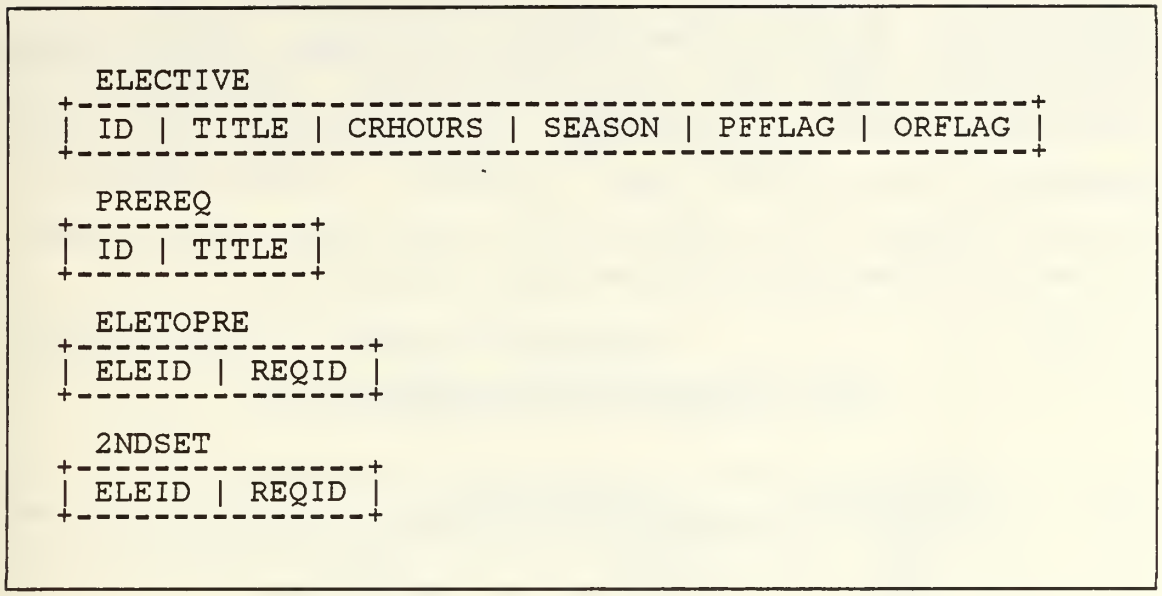

Figure 5.1 Data Base Relations of CAS

The validation process was actually conducted as two different operations. In the first operation, the previously obtained correlations of the original sample were cross-validated with the correlations among the test sample. During the second operation, the CAS was run with the test sample's data, and the predictions of the system were compared to the actual grades of the individuals, against the confidence level. A pre-determined confidence level of 90 % was sought throughout the tests. The observed results are discussed below.

2. Results

Considering the common low-correlations problem in this field, the resulting figures of this research seem encouraging. They were greater than the statistically significance limits. For the cross-validation tests, an even higher correlation was observed between the major predictor (PAV), and the criterion (EAV), in the test sample. The

existance of the similar behaviors of correlations were exhibited also for the other three predictors, although they were somewhat lower than the original data. The correlation coefficients wight be improved, if this test sample were appended to the original group. However, it was not desirable to disturb the integrity of the data. The cross-validation correlations figures are in Table 4 .

TABLE 4

CROSS-VALIDATION CORRELATIONS

Variable Symbol	Correlations original group	test group
PAV	0.698	0.876
LNG	-0.550	-0.352
SEX	0.265	0.136
RFS	-0.227	-0.207

For the second validation process, the CAS predicted 32 students' performances, using the same test group's data. When the predictions were compared to the actual grades of the tested students, results satisfied the 90 % confidence level objective. Detailed figures are in Table 5 .

TABLE 5

VALIDATION TEST RESULTS

Number of Predictions	: 32
Actual Error in Prediction	: (+/-) 0.09/4
Percentage Error	: 9.51 %
Desired confidence level	: 90.00 %
Obtained confidence level	: 90.49 %
Conclusion	: Predictive model is valid

The system predicted the QPR points of a student for each elective course on the scale of 0 to 4. The actual error in prediction is the average error of this prediction. It was calculated using the formula below:

Actual Error in Prediction = (5.1)

Actual QPR - Predicted QPR

The percentage error is the percentage of the actual error in prediction.

Percentage Error = (5.2)

100 * (actual error in prediction) / (actual QPR)

With respect to the test results, the model and implemented system seem to be valid.

VI. CONCLUSION AND SUGGESTIONS FOR FUTURE RESEARCH

A. CONCLUSION

1. Summary

The objective of this thesis was to provide a means for predicting student performance in elective courses. Four predictors were used, namely: prerequisite course GPA (PAV), language (LNG), sex (SEX), and refresher (RFS). The corresponding prediction model was successfully developed. The scope was limited to the CSM curriculum students and its elective courses. The findings and the formulations, were implemented in a computer system, referred to as CAS (Computerized Advising System). No computer program, or any other tool can replace human decision making in the advising process. The intent is to support, rather than replace human judgement. Therefore the findings and the prototype product of this thesis will only be helpful, only if used in the company of current course selection procedures.

2. Overlaps With Prior Research

Three commonly discovered correlates of performance in the prior research are : ability, sex, and socioeconomic status. [Ref. 3: p. 43] Compared to this research's findings LNG and RFS might correspond to the ability factor. Socioeconomic, status however, was regarded as fairly homogeneous, with no significant variations among the student population of the NPS. Some recent studies involving the language factor, further emphasize its importance and distinguishes from ability factors.(Sprinks, Chinese students in University of Hong Kong; Abadzi, International student admissions; deWolf, in University of Washington) [Refs. 11,12,13] This point is also confirmed here.

What differed from the traditional research in this thesis was the test of connecting the course content to

student performance. Course content was represented by its prerequisites, and prerequisite courses' performance exhibited high correlations with elective courses' performances.

B. FUTURE RESEARCH

Future research may proceed in two ways. One is to limit the scope while going into more depth by adding new factors, or by trying different approaches. The other way is to keep the depth of the analysis the same , and to expand the application. Using both approaches is also possible , and may produce fruitful results.

1. Penetrating the Depth

There may be questions about the socioeconomic homogeneity assumption. Because in fact, some considerable cultural differences, as well as income differences, may exist between American and Foreign students. The possible influence of this factor could be investigated. In such a future attempt, use of salary indices would be a better alternative than the direct use of salary figures.

Also the linearity assumption of this research may be investigated. Even though there is no evidence against this assumption, it would still be worthwhile to try other assumptions. Future research may be addressed to discovering the instances in which the relationship of a variable to a criterion is curvi-linear rather than linear.

2. Expanding the Breadth

This thesis could be repeated for the other curricula, or even for all curricula of the school. In such an attempt, though, researchers should be careful about examining whether the same predictors would be legitimate for the other curricula. If there is a doubt or clue of for instance, the achievement may be dependent on any special aptitude, then the research must be conducted accordingly.

Since the prerequisite courses' performance correlate with their related elective's performance, the

application may be expanded to predict any course's performance. For this purpose, 'marital-status', 'number-of-children', 'inter-curriculum-transfer', and 'highest-degree' variables seem promising.

Researchers are also encouraged to revise and refine the CAS implementation of this thesis. Any change in the prediction model can be directly applied to the embedded formula, without a need for modification of the code, or without any side effects within the system.

APPENDIX A

MINITAB OUTPUTS

```
--
read '$d20' into c1 c2 c3 c4 c5 c6 c7 c8 c9 c10 c11 c12 c13 c14 c15 c16 c17
```

COLUMN	C1	C2	C3	C4	C5	C6
COUNT	34	34	34	34	34	34
ROW						
1	3.30000	3.73500	0.	0.	0.	32.
2	3.48000	3.13800	0.	0.	0.	35.
3	3.50000	3.43000	0.	0.	0.	37.
4	3.35000	3.27500	0.	0.	0.	38.
. . .						

COLUMN	C7	C8	C9	C10	C11	C12
COUNT	34	34	34	34	34	34
ROW						
1	1.	0.	2.	0.	9.	3.
2	0.	1.	5.	0.	10.	3.
3	0.	1.	5.	0.	11.	3.
4	0.	3.	4.	0.	15.	3.
. . .						

COLUMN	C13	C14	C15	C16	C17
COUNT	34	34	34	34	34
ROW					
1	0.	3.	2.	2.	0.
2	1.	4.	1.	1.	1.
3	0.	2.	0.	1.	0.
4	0.	1.	0.	2.	0.
. . .					

```
--
name c1 'eav' c2 'pav' c3 'cty' c4 'lng' c5 'sex' c6 'age' c7 'mrt' c8 'chld'
--
```

```
name c9 'loc' c10 'svc' c11 'year' c12 'rnk' c13 'mor' c14 'hidg'
--
name c15 'rlt' c16 'rfs' c17 'trs'
--
********** ******** **********
--
****** correlation analysis starts ********
--
corr c1 c2

   CORRELATION OF      EAV AND PAV     = 0.698

--
corr c1 c3

   CORRELATION OF      EAV AND CTY     =-0.508

--
corr c1 c4

   CORRELATION OF      EAV AND LNG     =-0.550

--
corr c1 c5

   CORRELATION OF      EAV AND SEX     = 0.265

corr c1 c6
--

   CORRELATION OF      EAV AND AGE     =-0.173

--
corr c1 c7

   CORRELATION OF      EAV AND MRT     = 0.272

--
corr c1 c8

   CORRELATION OF      EAV AND CHLD    =-0.142
```

```
--
corr c1 c9

   CORRELATION OF      EAV AND LOC     = 0.097

--
corr c1 c10

   CORRELATION OF      EAV AND SVC     = 0.004

--
corr c1 c11

   CORRELATION OF      EAV AND YEAR    =-0.139

--
corr c1 c12

   CORRELATION OF      EAV AND RNK     = 0.089

--
corr c1 c13

   CORRELATION OF      EAV AND MOR     =-0.158

--
corr c1 c14

   CORRELATION OF      EAV AND HIDG    =-0.202

--
corr c1 c15

   CORRELATION OF      EAV AND RLT     =-0.051

--
corr c1 c16

   CORRELATION OF      EAV AND RFS     =-0.228

--
corr c1 c17

   CORRELATION OF      EAV AND TRS     =-0.227
```

```
--
******* ********* *********
--
******* inter-correlations
--
corr c2 c3
   CORRELATION OF      PAV AND CTY     =-0.071
--
corr c2 c4
   CORRELATION OF      PAV AND LNG     =-0.115
--
corr c3 c4
   CORRELATION OF      CTY AND LNG     = 0.930
--
corr c5 c6
   CORRELATION OF      SEX AND AGE     =-0.166
--
corr c6 c11
   CORRELATION OF      AGE AND YEAR    = 0.831
--
corr c16 c17
   CORRELATION OF      RFS AND TRS     =-0.028
--
corr c7 c8
   CORRELATION OF      MRT AND CHLD    =-0.601
--
corr c7 c9
```

```
   CORRELATION OF      MRT AND LOC     = 0.026

--
corr c13 c14

   CORRELATION OF      MOR AND HIDG    = 0.560

--
corr c6 c16

   CORRELATION OF      AGE AND RFS     = 0.121

--
corr c5 c16

   CORRELATION OF      SEX AND RFS     =-0.145

--
corr c2 c5

   CORRELATION OF      PAV AND SEX     =-0.035

--
corr c2 c16

   CORRELATION OF      PAV AND RFS     = 0.097

--
********* *********** ************* ***********
--
******* regression analysis starts

--
brief
--
regress c1 on 1 predictor in c2

THE REGRESSION EQUATION IS
Y =   0.623 + 0.811 X1

                                    ST. DEV.    T-RATIO =
```

```
       COLUMN     COEFFICIENT        OF COEF.    COEF/S.D.
       --             0.6229          0.5065         1.23
X1     PAV            0.8111          0.1469         5.52

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 0.2190
WITH (  34- 2) =  32 DEGREES OF FREEDOM

R-SQUARED = 48.8 PERCENT
R-SQUARED = 47.2 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

 DUE TO     DF           SS      MS=SS/DF
REGRESSION   1      1.46128       1.46128
RESIDUAL    32      1.53475       0.04796
TOTAL       33      2.99603

--
regress c1 on 2 predictors in c2 c4

THE REGRESSION EQUATION IS
Y =   0.913 + 0.748 X1 - 0.350 X2

                                   ST. DEV.    T-RATIO =
       COLUMN     COEFFICIENT     OF COEF.    COEF/S.D.
       --             0.9133          0.3905         2.34
X1     PAV            0.7476          0.1127         6.63
X2     LNG           -0.34982         0.07126       -4.91

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 0.1669
WITH (  34- 3) =  31 DEGREES OF FREEDOM

R-SQUARED = 71.2 PERCENT
R-SQUARED = 69.3 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

 DUE TO     DF           SS      MS=SS/DF
REGRESSION   2      2.13255       1.06628
```

```
RESIDUAL    31      0.86348       0.02785
TOTAL       33      2.99604

--
regress c1 on 3 predictors in c2,c4,c5

THE REGRESSION EQUATION IS
Y =   0.836 + 0.761 X1 - 0.318 X2
    + 0.164 X3

                                    ST. DEV.    T-RATIO =
       COLUMN     COEFFICIENT       OF COEF.    COEF/S.D.
       --            0.8356          0.3728        2.24
X1     PAV           0.7613          0.1073        7.10
X2     LNG          -0.31842         0.06935      -4.59
X3     SEX           0.16417         0.07870       2.09

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 0.1585
WITH (  34- 4) =  30 DEGREES OF FREEDOM

R-SQUARED = 74.8 PERCENT
R-SQUARED = 72.3 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

 DUE TO     DF          SS       MS=SS/DF
REGRESSION   3      2.24194       0.74731
RESIDUAL    30      0.75409       0.02514
TOTAL       33      2.99603

--
regress c1 on 4 predictors in c2,c4,c5,c7

THE REGRESSION EQUATION IS
Y =   0.832 + 0.763 X1 - 0.319 X2
    + 0.169 X3 -0.0060 X4

                                    ST. DEV.    T-RATIO =
       COLUMN     COEFFICIENT       OF COEF.    COEF/S.D.
```

```
        --            0.8315          0.3831         2.17
X1      PAV           0.7628          0.1110         6.87
X2      LNG          -0.31853         0.07054       -4.52
X3      SEX           0.1692          0.1043         1.62
X4      MRT          -0.00604         0.08068       -0.07

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 0.1612
WITH (  34- 5) =  29 DEGREES OF FREEDOM

R-SQUARED = 74.8 PERCENT
R-SQUARED = 71.4 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

 DUE TO     DF          SS        MS=SS/DF
REGRESSION   4       2.24209       0.56052
RESIDUAL    29       0.75394       0.02600
TOTAL       33       2.99603

--
regress c1 on 4 predictors in c2,c4,c5,c8

THE REGRESSION EQUATION IS
Y =   0.850 + 0.763 X1 - 0.318 X2
    + 0.144 X3 -0.0175 X4

                                    ST. DEV.    T-RATIO =
       COLUMN     COEFFICIENT       OF COEF.    COEF/S.D.
       --            0.8504          0.3775         2.25
X1     PAV           0.7628          0.1085         7.03
X2     LNG          -0.31819         0.07008       -4.54
X3     SEX           0.14435         0.08586        1.68
X4     CHLD         -0.01750         0.02858       -0.61

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 0.1602
WITH (  34- 5) =  29 DEGREES OF FREEDOM

R-SQUARED = 75.2 PERCENT
```

R-SQUARED = 71.7 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	4	2.25157	0.56289
RESIDUAL	29	0.74447	0.02567
TOTAL	33	2.99603	

--

regress c1 on 5 predictors in c2,c4,c5,c7,c13

THE REGRESSION EQUATION IS

Y = 0.761 + 0.782 X1 - 0.313 X2
+ 0.165 X3 -0.0052 X4 +0.0386 X5

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	0.7612	0.4413	1.72
X1	PAV	0.7821	0.1263	6.19
X2	LNG	-0.31344	0.07321	-4.28
X3	SEX	0.1651	0.1066	1.55
X4	MRT	-0.00518	0.08198	-0.06
X5	MOR	0.0386	0.1141	0.34

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS

S = 0.1638

WITH (34- 6) = 28 DEGREES OF FREEDOM

R-SQUARED = 74.9 PERCENT

R-SQUARED = 70.5 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	5	2.24515	0.44903
RESIDUAL	28	0.75088	0.02682
TOTAL	33	2.99603	

--

```
regress c1 on 5 predictors in c2,c4,c5,c7,c14

THE REGRESSION EQUATION IS
Y =   0.867 + 0.759 X1 - 0.310 X2
    + 0.172 X3 -0.0056 X4 -0.0104 X5

                                        ST. DEV.    T-RATIO =
       COLUMN     COEFFICIENT          OF COEF.    COEF/S.D.
       --             0.8670            0.3952        2.19
X1     PAV            0.7587            0.1128        6.73
X2     LNG          -0.31039           0.07348       -4.22
X3     SEX            0.1723            0.1059        1.63
X4     MRT          -0.00559           0.08177       -0.07
X5     HIDG         -0.01042           0.02171       -0.48

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 0.1634
WITH (  34- 6) =  28 DEGREES OF FREEDOM

R-SQUARED = 75.0 PERCENT
R-SQUARED = 70.6 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

 DUE TO      DF           SS       MS=SS/DF
REGRESSION    5       2.24825        0.44965
RESIDUAL     28       0.74779        0.02671
TOTAL        33       2.99603

--
regress c1 on 6 predictors in c2,c4,c5,c7,c14,c16

THE REGRESSION EQUATION IS
Y =   0.912 + 0.793 X1 - 0.257 X2
    + 0.191 X3 -0.0411 X4 -0.0278 X5
    -0.0854 X6

                                        ST. DEV.    T-RATIO =
       COLUMN     COEFFICIENT          OF COEF.    COEF/S.D.
       --             0.9117            0.3712        2.46
```

X1	PAV	0.7927	0.1069	7.42
X2	LNG	-0.25664	0.07312	-3.51
X3	SEX	0.19123	0.09972	1.92
X4	MRT	-0.04110	0.07837	-0.52
X5	HIDG	-0.02784	0.02184	-1.27
X6	RFS	-0.08536	0.03881	-2.20

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 0.1533
WITH (34- 7) = 27 DEGREES OF FREEDOM

R-SQUARED = 78.8 PERCENT
R-SQUARED = 74.1 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	6	2.36185	0.39364
RESIDUAL	27	0.63418	0.02349
TOTAL	33	2.99603	

--
regress c1 on 7 predictors in c2,c4,c5,c7,c11,c13,c16

THE REGRESSION EQUATION IS
Y = 0.871 + 0.791 X1 - 0.288 X2
+ 0.177 X3 -0.0450 X4 -0.0033 X5
-0.0106 X6 -0.0689 X7

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	0.8705	0.4394	1.98
X1	PAV	0.7913	0.1242	6.37
X2	LNG	-0.28850	0.07313	-3.94
X3	SEX	0.1766	0.1061	1.66
X4	MRT	-0.04503	0.08669	-0.52
X5	YEAR	-0.003324	0.009835	-0.34
X6	MOR	-0.0106	0.1174	-0.09
X7	RFS	-0.06892	0.03932	-1.75

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 0.1604
WITH (34- 8) = 26 DEGREES OF FREEDOM

R-SQUARED = 77.7 PERCENT
R-SQUARED = 71.7 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	7	2.32715	0.33245
RESIDUAL	26	0.66888	0.02573
TOTAL	33	2.99603	

--
regress c1 on 8 predictors in c2,c4,c5,c7,c11,c13,c16,c17

THE REGRESSION EQUATION IS
Y = 0.838 + 0.805 X1 - 0.274 X2
+ 0.189 X3 -0.0645 X4 -0.0034 X5
+0.0442 X6 -0.0679 X7 -0.0927 X8

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	0.8378	0.4358	1.92
X1	PAV	0.8050	0.1235	6.52
X2	LNG	-0.27401	0.07332	-3.74
X3	SEX	0.1888	0.1054	1.79
X4	MRT	-0.06453	0.08723	-0.74
X5	YEAR	-0.003380	0.009735	-0.35
X6	MOR	0.0442	0.1244	0.36
X7	RFS	-0.06789	0.03893	-1.74
X8	TRS	-0.09270	0.07474	-1.24

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 0.1588
WITH (34- 9) = 25 DEGREES OF FREEDOM

R-SQUARED = 79.0 PERCENT

R-SQUARED = 72.2 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	8	2.36593	0.29574
RESIDUAL	25	0.63010	0.02520
TOTAL	33	2.99603	

--

regress c1 on 8 predictors in c2,c4,c5,c7,c11,c14,c16,c17

THE REGRESSION EQUATION IS

Y = 0.975 + 0.789 X1 - 0.259 X2
+ 0.192 X3 -0.0662 X4 -0.0050 X5
-0.0224 X6 -0.0847 X7 -0.0476 X8

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	0.9749	0.3950	2.47
X1	PAV	0.7889	0.1099	7.18
X2	LNG	-0.25873	0.07523	-3.44
X3	SEX	0.1917	0.1037	1.85
X4	MRT	-0.06615	0.08627	-0.77
X5	YEAR	-0.005019	0.009867	-0.51
X6	HIDG	-0.02237	0.02686	-0.83
X7	RFS	-0.08468	0.04044	-2.09
X8	TRS	-0.04759	0.08129	-0.59

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS

S = 0.1570

WITH (34- 9) = 25 DEGREES OF FREEDOM

R-SQUARED = 79.4 PERCENT

R-SQUARED = 72.9 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF

REGRESSION	8	2.37984	0.29748
RESIDUAL	25	0.61619	0.02465
TOTAL	33	2.99603	

--

regress c1 on 9 predictors in c2,c4,c5,c6,c7,c11,c14,c16,c17

THE REGRESSION EQUATION IS

Y = 1.09 + 0.788 X1 - 0.258 X2
+ 0.206 X3 -0.0049 X4 -0.0733 X5
-0.0010 X6 -0.0218 X7 -0.0831 X8
-0.0416 X 9

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	1.0945	0.6204	1.76
X1	PAV	0.7884	0.1121	7.04
X2	LNG	-0.25846	0.07669	-3.37
X3	SEX	0.2057	0.1193	1.72
X4	AGE	-0.00488	0.01926	-0.25
X5	MRT	-0.07334	0.09240	-0.79
X6	YEAR	-0.00102	0.01872	-0.05
X7	HIDG	-0.02178	0.02748	-0.79
X8	RFS	-0.08312	0.04168	-1.99
X9	TRS	-0.04163	0.08612	-0.48

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 0.1600
WITH (34-10) = 24 DEGREES OF FREEDOM

R-SQUARED = 79.5 PERCENT
R-SQUARED = 71.8 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	9	2.38148	0.26461
RESIDUAL	24	0.61455	0.02561
TOTAL	33	2.99603	

```
--
regress c1 on 4 predictors in c2,c4,c5,c13

THE REGRESSION EQUATION IS
Y =   0.764 + 0.781 X1 - 0.313 X2
    + 0.161 X3 +0.0388 X4

                                        ST. DEV.    T-RATIO =
       COLUMN     COEFFICIENT          OF COEF.    COEF/S.D.
       --            0.7643             0.4309        1.77
X1     PAV           0.7809             0.1228        6.36
X2     LNG          -0.31331            0.07192      -4.36
X3     SEX           0.16082            0.08046       2.00
X4     MOR           0.0388             0.1121        0.35

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 0.1609
WITH (  34- 5) =  29 DEGREES OF FREEDOM

R-SQUARED = 74.9 PERCENT
R-SQUARED = 71.5 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

 DUE TO     DF          SS        MS=SS/DF
REGRESSION   4       2.24504       0.56126
RESIDUAL    29       0.75099       0.02590
TOTAL       33       2.99603

--
regress c1 on 4 predictors in c2,c4,c5,c14

THE REGRESSION EQUATION IS
Y =   0.871 + 0.757 X1 - 0.310 X2
    + 0.168 X3 -0.0104 X4

                                        ST. DEV.    T-RATIO =
       COLUMN     COEFFICIENT          OF COEF.    COEF/S.D.
       --            0.8708             0.3844        2.27
```

X1	PAV	0.7573	0.1090	6.95
X2	LNG	-0.31027	0.07219	-4.30
X3	SEX	0.16769	0.08004	2.10
X4	HIDG	-0.01044	0.02133	-0.49

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 0.1606
WITH (34- 5) = 29 DEGREES OF FREEDOM

R-SQUARED = 75.0 PERCENT
R-SQUARED = 71.6 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	4	2.24812	0.56203
RESIDUAL	29	0.74791	0.02579
TOTAL	33	2.99603	

--
regress c1 on 4 predictors in c2,c4,c14,c16

THE REGRESSION EQUATION IS
Y = 1.00 + 0.771 X1 - 0.288 X2
-0.0243 X3 -0.0859 X4

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	1.0016	0.3824	2.62
X1	PAV	0.7710	0.1089	7.08
X2	LNG	-0.28813	0.07465	-3.86
X3	HIDG	-0.02432	0.02268	-1.07
X4	RFS	-0.08595	0.03952	-2.17

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 0.1598
WITH (34- 5) = 29 DEGREES OF FREEDOM

R-SQUARED = 75.3 PERCENT
R-SQUARED = 71.9 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	4	2.25564	0.56391
RESIDUAL	29	0.74039	0.02553
TOTAL	33	2.99603	

--

regress c1 on 4 predictors in c2,c4,c14,c17

THE REGRESSION EQUATION IS

Y = 0.963 + 0.734 X1 - 0.347 X2
+0.0051 X3 -0.0768 X4

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	0.9627	0.4063	2.37
X1	PAV	0.7343	0.1157	6.35
X2	LNG	-0.34684	0.07431	-4.67
X3	HIDG	0.00507	0.02571	0.20
X4	TRS	-0.07682	0.08352	-0.92

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS

S = 0.1699

WITH (34- 5) = 29 DEGREES OF FREEDOM

R-SQUARED = 72.1 PERCENT

R-SQUARED = 68.2 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	4	2.15932	0.53983
RESIDUAL	29	0.83671	0.02885
TOTAL	33	2.99603	

--

regress c1 on 4 predictors in c2,c4,c5,c16

THE REGRESSION EQUATION IS

Y = 0.843 + 0.785 X1 - 0.288 X2
+ 0.152 X3 -0.0643 X4

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	0.8432	0.3593	2.35
X1	PAV	0.7853	0.1042	7.53
X2	LNG	-0.28768	0.06893	-4.17
X3	SEX	0.15181	0.07614	1.99
X4	RFS	-0.06427	0.03536	-1.82

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS

S = 0.1528

WITH (34- 5) = 29 DEGREES OF FREEDOM

R-SQUARED = 77.4 PERCENT

R-SQUARED = 74.3 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	4	2.31907	0.57977
RESIDUAL	29	0.67695	0.02334
TOTAL	33	2.99603	

--

regress c1 on 4 predictors in c2,c4,c5,c17

THE REGRESSION EQUATION IS

Y = 0.897 + 0.747 X1 - 0.312 X2
+ 0.165 X3 -0.0700 X4

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	0.8966	0.3772	2.38
X1	PAV	0.7474	0.1080	6.92
X2	LNG	-0.31228	0.06954	-4.49
X3	SEX	0.16482	0.07862	2.10

```
X4     TRS          -0.06996         0.06807        -1.03

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 0.1584
WITH (  34- 5) =  29 DEGREES OF FREEDOM

R-SQUARED = 75.7 PERCENT
R-SQUARED = 72.4 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

 DUE TO     DF           SS       MS=SS/DF
REGRESSION   4       2.26844        0.56711
RESIDUAL    29       0.72759        0.02509
TOTAL       33       2.99603

--
regress c1 on 5 predictors in c2,c4,c5,c14,c16

THE REGRESSION EQUATION IS
Y =   0.937 + 0.781 X1 - 0.258 X2
    + 0.158 X3 -0.0271 X4 -0.0812 X5

                                      ST. DEV.     T-RATIO =
      COLUMN     COEFFICIENT        OF COEF.     COEF/S.D.
      --            0.9367           0.3634          2.58
X1    PAV           0.7812           0.1032          7.57
X2    LNG          -0.25845          0.07208        -3.59
X3    SEX           0.15770          0.07553         2.09
X4    HIDG         -0.02710          0.02151        -1.26
X5    RFS          -0.08117          0.03749        -2.17

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 0.1513
WITH (  34- 6) =  28 DEGREES OF FREEDOM

R-SQUARED = 78.6 PERCENT
R-SQUARED = 74.8 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE
```

DUE TO	DF	SS	MS=SS/DF
REGRESSION	5	2.35539	0.47108
RESIDUAL	28	0.64064	0.02288
TOTAL	33	2.99603	

--

regress c1 on 5 predictors in c2,c4,c5,c14,c17

THE REGRESSION EQUATION IS

Y = 0.896 + 0.747 X1 - 0.312 X2

+ 0.165 X3 +0.0001 X4 -0.0702 X5

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	0.8963	0.3869	2.32
X1	PAV	0.7474	0.1100	6.80
X2	LNG	-0.31236	0.07250	-4.31
X3	SEX	0.16478	0.08041	2.05
X4	HIDG	0.00013	0.02452	0.01
X5	TRS	-0.07016	0.07933	-0.88

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS

S = 0.1612

WITH (34- 6) = 28 DEGREES OF FREEDOM

R-SQUARED = 75.7 PERCENT

R-SQUARED = 71.4 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	5	2.26844	0.45369
RESIDUAL	28	0.72759	0.02599
TOTAL	33	2.99603	

--

nobrief

--

regress c1 on 4 predictors in c2,c4,c5,c16

THE REGRESSION EQUATION IS

Y = 0.843 + 0.785 X1 - 0.288 X2

+ 0.152 X3 -0.0643 X4

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	0.8432	0.3593	2.35
X1	PAV	0.7853	0.1042	7.53
X2	LNG	-0.28768	0.06893	-4.17
X3	SEX	0.15181	0.07614	1.99
X4	RFS	-0.06427	0.03536	-1.82

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS

S = 0.1528

WITH (34- 5) = 29 DEGREES OF FREEDOM

R-SQUARED = 77.4 PERCENT

R-SQUARED = 74.3 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	4	2.31907	0.57977
RESIDUAL	29	0.67695	0.02334
TOTAL	33	2.99603	

FURTHER ANALYSIS OF VARIANCE

SS EXPLAINED BY EACH VARIABLE WHEN ENTERED IN THE ORDER GIVEN

DUE TO	DF	SS
REGRESSION	4	2.31907
PAV	1	1.46128
LNG	1	0.67128
SEX	1	0.10939
RFS	1	0.07713

ROW	X1 PAV	Y EAV	PRED. Y VALUE	ST.DEV. PRED. Y	RESIDUAL	ST.RES.

1	3.73	3.3000	3.6477	0.0465	-0.3477	-2.39R
2	3.14	3.4800	3.2431	0.0477	0.2369	1.63
3	3.43	3.5000	3.4724	0.0356	0.0276	0.19
4	3.27	3.3500	3.2864	0.0444	0.0636	0.43
5	3.45	3.6500	3.4258	0.0388	0.2242	1.52
6	3.59	3.6500	3.6856	0.0753	-0.0356	-0.27
7	3.18	3.3000	3.2781	0.0448	0.0219	0.15
8	3.72	3.8600	3.7613	0.0677	0.0987	0.72
9	3.08	3.5000	3.4156	0.0854	0.0844	0.67 X
10	3.52	3.3000	3.4828	0.0388	-0.1828	-1.24
11	3.65	3.6500	3.5789	0.0421	0.0710	0.48
12	3.29	3.5000	3.5786	0.0806	-0.0786	-0.61
13	3.45	3.4600	3.5493	0.0594	-0.0893	-0.63
14	2.67	2.4000	2.5205	0.0948	-0.1205	-1.01 X
15	3.61	3.6500	3.5495	0.0407	0.1005	0.68
16	3.74	3.7400	3.7786	0.0689	-0.0386	-0.28
17	3.39	3.1200	3.0922	0.0580	0.0278	0.20
18	3.58	3.5400	3.5291	0.0399	0.0109	0.07
19	3.66	3.7000	3.5888	0.0427	0.1112	0.76
20	3.59	3.2200	3.2477	0.0618	-0.0277	-0.20
21	3.59	3.1500	3.2500	0.0619	-0.1000	-0.72
22	3.08	3.0600	2.8441	0.0662	0.2159	1.57
23	3.70	3.5000	3.3305	0.0665	0.1695	1.23
24	3.41	3.6500	3.5190	0.0592	0.1310	0.93
25	3.58	3.5400	3.5291	0.0399	0.0109	0.07
26	3.69	3.6500	3.6123	0.0441	0.0377	0.26
27	3.57	3.5000	3.6738	0.0750	-0.1738	-1.31
28	3.43	3.3200	3.4097	0.0390	-0.0897	-0.61
29	3.01	2.8000	3.1446	0.0573	-0.3446	-2.43R
30	3.50	3.4000	3.4615	0.0386	-0.0616	-0.42
31	3.54	3.8500	3.6463	0.0745	0.2037	1.53
32	3.63	3.1800	3.3449	0.0718	-0.1649	-1.22
33	3.45	3.5000	3.4921	0.0356	0.0079	0.05
34	2.91	3.0000	2.9998	0.0714	0.0002	0.00

R DENOTES AN OBS. WITH A LARGE ST. RES.

X DENOTES AN OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 1.93

(X-PRIME X)INVERSE

	0	1	2	3	4
0	5.53006				
1	-1.58240	0.46543			
2	-0.17060	0.04660	0.20356		
3	-0.11780	0.01671	0.04219	0.24836	
4	-0.00633	-0.01998	-0.02561	0.01030	0.05356

--

stop

APPENDIX B

PROGRAM LISTINGS

```
************************** tez.prg ***********************************
*  Program name  : Tez
*  Author        : R. Tanju SIRMEN
*  Date          : November 1985
*  Description   : Gives the initial explenations about the system
*                  Initiates the whole process
*  Called by     : None
*  Calles        : quit.prg, gimme.prg, maint.prg
*  Input files   : None
*  Output files  : None
*  Local         : monitor,answer,ccolor,hcolor,mcolor,acolor,errcolor,
*                  rcolor,green,choice
**********************************************************************

SET TALK OFF
set deleted on
set escape on
set bell off
ERASE
store 'Y' to monitor
 12,19 say 'Are you using a color monitor (Y/N)?' get monitor picture '!'
read

do while .not. (monitor = 'Y' .or. monitor = 'N')
   do error
   12,55 get monitor picture '!'
   read
enddo

if (monitor) = 'Y'
* set the character color to bright yellow
   store 14 to ccolor
```

```
* set the header color to bright yellow on a blue background
   store 30 to hcolor
* set the message color to white on a red background
   store 79 to mcolor
* set the arrow color to blinking green
   store 138 to acolor
* set the result color to yellow on a red background
   store 78 to rcolor
* set the error color to flashing red
   store 140 to errcolor
* set the character color to green
   store 10 to green
else
* set the color to white on black
   store  7 to ccolor
   store 15 to hcolor
   store 15 to mcolor
   store 15 to acolor
   store 15 to rcolor
   store 15 to errcolor
   store 15 to green
endif
erase
   set color to 112,hcolor
    1,2  SAY IMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM;
MMMMMMMMMMMMMMMMMMMMMMMMM;
    2,2 SAY :
    3,2 SAY :
    4,2 SAY :
    5,2 SAY :
    6,2 SAY :
    7,2 SAY :
    8,2 SAY :
    9,2 SAY :
   10,2 SAY :
```

```
   11,2 SAY :
   12,2 SAY :
   13,2 SAY :
   14,2 SAY :
   15,2 SAY :
   16,2 SAY :
   17,2 SAY :
   18,2 SAY :
   19,2 SAY :
   20,2 SAY :
   21,2 SAY :
   22,2 SAY :
   23,2 SAY HMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM;
MMMMMMMMMMMMMMMMMMMMMMMMM<
   22,77 SAY :
   21,77 SAY :
   20,77 SAY :
   19,77 SAY :
   18,77 SAY :
   17,77 SAY :
   16,77 SAY :
   15,77 SAY :
   14,77 SAY :
   13,77 SAY :
   12,77 SAY :
   11,77 SAY :
   10,77 SAY :
    9,77 SAY :
    8,77 SAY :
    7,77 SAY :
    6,77 SAY :
    5,77 SAY :
    4,77 SAY :
    3,77 SAY :
    2,77 SAY :
```

```
set color to 112,green
 3,15 SAY IMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM;
 4,15 SAY :
 5,15 SAY :
 6,15 SAY :
 7,15 SAY :
 8,15 SAY :
 9,15 SAY :
10,15 SAY :
11,15 SAY :
12,15 SAY :
13,15 SAY :
14,15 SAY :
15,15 SAY :
16,15 SAY :
17,15 SAY :
18,15 SAY :
19,15 SAY :
20,15 SAY HMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM<
19,64 SAY :
18,64 SAY :
17,64 SAY :
16,64 SAY :
15,64 SAY :
14,64 SAY :
13,64 SAY :
12,64 SAY :
11,64 SAY :
10,64 SAY :
 9,64 SAY :
 8,64 SAY :
 7,64 SAY :
 6,64 SAY :
 5,64 SAY :
 4,64 SAY :
```

```
set color to 112,mcolor
 1,30 SAY    ASSISTANCE
set color to 112,hcolor
 3,30 SAY  By  R.Tanju SIRMEN
set color to 112,ccolor
 7,27 SAY This program will assist you
 8,26 SAY in selecting elective courses
 10,25 SAY *****     ***** *****     *****
 11,25 SAY   *****   B A N N E R   *****
store 'Y' to answer
set color to 112,mcolor
 21,23 SAY chr(7) + Do you want to continue (Y/N)?
set color to 112,ccolor
 21,53 GET answer picture '!'
read

do while .not. (answer = 'Y'.or. answer = 'N')
   do error
   store 'Y' to answer
   21,53 GET answer picture '!'
   read
enddo

if answer = 'N'
   do quit
endif

do while t

   erase
   set color to 112,green
   2,1 SAY ____________________________________________________________
   2,56 SAY ____________________
   set color to 112,hcolor
    4,33 SAY  MAIN  MENU
   set color to 112,ccolor
   11,24 SAY 1.   MAINTAIN DATABASE FILES
```

```
   13,24 SAY 2.     ASK FOR PREDICTION
   15,24 SAY           Q to Quit
   set color to 112,green
   18,1 SAY ____________________________________________________________
   18,56 SAY ________________________
   store '2' to choice
   set color to 112,mcolor
   22,25 SAY ' Your choice.....(1/2)? ' + chr(7)
   set color to 112,ccolor
   22,49 GET choice picture '!'
   read
   do while .not. (choice = '1' .OR. choice = '2' .or. choice = 'Q')
         do error
         set color to 112,ccolor
         22,49 GET choice picture '!'
         read
   enddo
   do case
      case (choice) = '1'
         do MAINT
      case (choice) = '2'
         do GIMME
      case (choice) = 'Q'
         do quit
   endcase
enddo
*****************************************************************************
*************************** MAINT.prg ***************************************
*  Program name : maint
*  Author       : R. Tanju SIRMEN
*  Date         : November 1985
*  Description  : This routine provides the main menu for the courses
*                 data base maintanance activities
*  Called by    : tez.prg
*  Calles       : new.prg, del.prg, edit.prg
```

```
*  Input files  : none
*  Output files : none
*  Local        : password, answ
*************************************************************************
set deleted on
set talk off
set exact on

ERASE
store '        ' to PASSWORD
set color to 112,mcolor
 13,27  SAY     PASSWORD PLEASE...
 13,47  get password picture '!!!!!!!!!'
set color to 0,0
read
if .not. (password = 'TURK    ')
   set color to 112,errcolor
   18,27  SAY chr(7) +  !! INCORRECT PASSWORD !!  + chr(7)
   set color to 112,mcolor
   22,27  SAY  Press any key to go back
   set console off
   wait
   set console on
   set exact off
   release password
   return
endif
do while t
   erase
   store ' ' to answ
   set color to 112,green
   3,1   SAY ____________________________________________________________
   3,56  SAY ________________________
   set color to 112,hcolor
   5,32  SAY        MAINTAIN MENU
   set color to 112,ccolor
```

```
 9,28 SAY 1.  INSERT AN ELECTIVE
12,28 SAY 2.  DELETE AN ELECTIVE
15,28 SAY 3.  EDIT AN ELECTIVE
18,28 SAY      Q to go back
set color to 112,green
20,1  SAY ____________________________________________________________________
20,56 SAY ________________________
do while .not. (val(answ) < 4 .and. val(answ) > 0 .OR.;
                  !(answ) = 'Q')
   store ' ' to answ
   set color to 122,mcolor
   23,26 SAY  Your choice...(1/2/3)?  + chr(7)
   set color to 112,ccolor
   23,50 GET answ PICTURE '!'
   read
   if .not. (val(answ) < 4 .and. val (answ) > 0 .or. ;
               (answ) = 'Q' )
      do error
   endif
enddo
if (answ) = 'Q'
   release password,answ
   return
endif
if (answ) = '1'
   do new
endif
if (answ) = '2'
   do del
endif
if (answ) = '3'
   do edit
endif
enddo
*******************************************************************************
```

```
******************************** NEW.prg **********************************
*  Program name : new
*  Author       : R. Tanju SIRMEN
*  Date         : November 1985
*  Description  : This program allows the user to enter new Elective
*                 Courses and their prerequisites into the database
*  Called by    : maint.prg
*  Calles       : getpre.prg
*  Input files  : elective.dbf, elective.ndx
*  Output files : same as input files
*  Local        : n:answ,t:id,t:reqid,t:title,t:crhours,t:pfflag,t:season
*                 t:orflag,n:entry,n:correct,t:docorr,t:date,n:mistake
***************************************************************************
set talk off
erase
store 'Y' to n:answ
set color to 112,green
 2,1 SAY ____________________________________________________________
 2,56 SAY ____________________________
set color to 112,hcolor
 4,30 SAY  INSERT NEW ELECTIVE
set color to 112,ccolor
  9,23 SAY This program will allow you to enter
 10,26 SAY new Elective Courses and their
 11,25 SAY prerequisites into the database
 12,24 SAY The course will be checked to make
 13,25 SAY sure that it is not a duplicate
set color to 112,green
 18,1 SAY ___________________________________________________________
 18,56 SAY ____________________________
set color to 112,mcolor
 21,24 SAY  Do you want to continue (Y/N)?  + chr(7)
set color to 112,ccolor
 21,56 GET n:answ picture '!'
set color to 112,ccolor
```

```
read

do while .not. ((n:answ = Y) .or. (n:answ = N))
   do error
   set color to 112,ccolor
   21,56 get n:answ picture '!'
   read
enddo

if (n:answ) = 'N'
   release all like n:*
   return
endif

do while t

  store '      ' to t:id
  store '      ' to t:reqid
  store '                                ' to t:title
  store '   ' to t:crhours
  store 'NO ' to t:pfflag
  store '  ' to t:season
  store ' ' to t:orflag

  use elective index elective

  store f to n:entry

  do while .not. n:entry
      store 'N' to n:correct
      store 'N' to t:docorr
      ERASE
      store DATE() to t:date
      set color to 112,hcolor
      1,5 SAY  DATA ENTRY FOR NEW ELECTIVE COURSE
      1,60 SAY DATE:  + t:date
      set color to 112,green
      2,1 SAY ________________________________________________________________
      2,56 SAY ________________________
```

```
set color to 112,ccolor
6,3  SAY Course ID    : GET t:id PICTURE !!9999
8,3  SAY A Blank ID returns you back
read
clear gets

if (t:id) = '      '
    erase
    release all like t:*
    return
endif

*  Check for a duplicate entry
find &t:id
if # <> 0
   erase
   set color to 112,hcolor
   2,32 SAY  REJECTED ENTRY
   set color to 112,green
   4,1 SAY ____________________________________________________________
   4,56 SAY ____________________________
   set color to 112,ccolor
   6,18 SAY  This course already exists in the database as
   8, 23 SAY ID           :  + ID
   10,23 SAY Title        :  + TITLE
   12,23 SAY Credit Hours :  + CRHOURS
   14,23 SAY Pass/Fail    :
   if pfflag = '0'
      14,38 SAY NO
   else * pfflag = '1'
      14,38 SAY YES
   endif
   16,23 SAY Season       :  + SEASON
   set color to 112,green
   18,1 SAY ___________________________________________________________
   18,56 SAY ____________________________
```

```
   set color to 112,ccolor
   20,23 SAY You may edit the course by choosing
   21,27 SAY the EDIT obtion at the menu
   set color to 112,mcolor
   23,27 SAY  ' Press a key to continue...' + chr (7)
   store '      ' to t:id
   SET CONSOLE OFF
   WAIT
   SET CONSOLE ON
   ERASE
else
   store t to n:mistake
   do while n:mistake
       store f to n:mistake
       if t:docorr = 'Y'
          20,20 SAY
          set color to 112,mcolor
          20,27 SAY   Do the corrections ... + chr(7)
          set color to 112,ccolor
          store 'N' to t:docorr
       endif
       6,18  SAY t:id
        8,3  SAY Title        : get t:title picture '!!!!!!!!!!!!!!!!!!!!
       10,3  SAY Credit Hours : get t:crhours picture '9.9'
       12,3  SAY Pass/Fail    : get t:pfflag picture '!!!!'
       14,3  SAY Season       : get t:season picture '!!!'

       set color to 112,green
       18,1 SAY ____________________________________________________________
       18,56 SAY ________________________
       set color to 112,ccolor
       read
       clear gets
       if .not. (t:pfflag = 'YES' .or. t:pfflag = 'NO ')
            do error
            set color to 112,acolor
```

```
                12,23 say '<<=='
                set color to 112,ccolor
                12,28 say 'YES/NO'
                store 'N' to n:correct
                store 'Y' to t:docorr
                store t to n:mistake
            endif
        enddo
        12,23 say '           '
        set color to 112,mcolor
        20,20 SAY  Are all the entries correct...(Y/N)?  + chr (7)
        set color to 112,ccolor
        22,70 say '         '
        23,70 say '         '
        20,57 GET n:correct picture '!'
        read
        do while .not. (n:correct = 'Y' .or. n:correct = 'N')
          do error
          20,57 GET n:correct picture '!'
          read
        enddo
        if n:correct = 'Y'
           store t to n:entry
        endif
     endif
enddo
store (trim(t:title)) to t:title
append blank
replace ID with t:id
replace TITLE with t:title
replace CRHOURS with t:crhours
do case
    case t:pfflag = 'NO '
        store '0' to t:pfflag
    case t:pfflag = 'YES'
```

```
            store '1' to t:pfflag
   endcase
   replace PFFLAG with t:pfflag
   replace SEASON with t:season

   20,20 SAY

do getpre

enddo
*************************************************************************
************************** GETPRE.prg ***********************************
*  Program name : getpre
*  Author       : R. Tanju SIRMEN
*  Date         : November 1985
*  Description  : This routine is used to get the prerequisite courses
*                 of the new elective being entered
*  Called by    : new.prg
*  Calles       : found.prg
*  Input files  : elective.dbf, prereq.dbf, eletopre.dbf, 2ndset.dbf,
*                 elective.ndx, prereq.ndx, eletopre.ndx, 2ndset.ndx
*  Output files : same as input files
*  Local        : t:rcorr,t:frid,t:srid,t:trid,t:urid,t:irid,
*                 t:forrid,t:sorrid,t:torrid,t:uorrid,t:iorrid,
*                 t:frtit,t:rtit,t:ortit,t:rid,prereq
*************************************************************************

   store 'N' to t:rcorr
   store '      ' to t:frid
*  t:frid = first requisite id
   store '      ' to t:srid
*  t:srid = second req. id
   store '      ' to t:trid
*  t:trid = third req. id
   store '      ' to t:urid
*  t:orid = forth req.id
   store '      ' to t:irid
```

```
*  t:irid = fifth rq. id
   store '      ' to t:forrid
*  t:forrid = first or requisite id
   store '      ' to t:sorrid
*  t:sorrid = second or requisite id
   store '      ' to t:torrid
*  t:torrid = third or req. id
   store '      ' to t:uorrid
*  t:uorrid = forth or req.id
   store '      ' to t:iorrid
*  t:iorrid = fifth or rq. id

   store '                                        ' to t:frtit
*  t:frtit = first requisite title
   store '                                        ' to t:rtit
*  t:rtit = requisite title
   store '                                        ' to t:ortit
*  t:ortit = or requisite title

   do while t:rcorr = 'N'
      store t to prereq
      set color to 112,green
       6,47 SAY Prerequisite  Courses
       7,30 say ZDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD
       8,30 say 3
       9,30 say 3
      10,30 say 3
      11,30 say 3
      12,30 say 3
      13,30 say 3
      14,30 say 3
      15,30 say 3
      16,30 say 3
      17,30 say 3
      18,30 say 3
      set color to 112,ccolor
```

```
 8,35 say 1.ID : get t:frid picture '!!9999'
read
if .not. (t:frid = '      ')
   8,56 SAY or : get t:forrid picture '!!9999'
  read
  10,35 say 2.ID : get t:srid picture '!!9999'
  read
  if .not. (t:srid = '      ')
    10,56 SAY or : get t:sorrid picture '!!9999'
    read
    12,35 say 3.ID : get t:trid picture '!!9999'
    read
    if .not. (t:trid = '      ')
      12,56 SAY or : get t:torrid picture '!!9999'
      read
      14,35 say 4.ID : get t:urid picture '!!9999'
      read
      if .not. (t:urid = '      ')
        14,56 SAY or : get t:uorrid picture '!!9999'
        read
        16,35 say 5.ID : get t:irid picture '!!9999'
        read
        if .not. (t:irid = '      ')
          16,56 SAY or : get t:iorrid picture '!!9999'
          read
        endif
      endif
    endif
  endif
endif
set color to 112,mcolor
20,20 SAY  Are all the entries correct...(Y/N)?  + chr (7)
set color to 112,ccolor
22,70 say '         '
23,70 say '         '
```

```
   20,57 GET t:rcorr picture '!'
   read
   do while .not. (t:rcorr = 'Y' .or. t:rcorr = 'N')
      do error
      20,57 GET t:rcorr picture '!'
      read
   enddo
enddo

 8,56 SAY
10,35 say
12,35 say
14,35 say
16,35 say
if (t:frid = '      ')
  8,35 say No prerequisite for  + t:id
else
   8,35 say 1.ID    : + t:frid
  if .not. (t:forrid = '      ')
     8,56 SAY or    : + t:forrid
  endif
  if .not. (t:srid = '      ')
       9,35 say 2.ID    : + t:srid
      if .not. (t:sorrid = '      ')
         9,56 SAY or    : + t:sorrid
      endif
      if .not. (t:trid = '      ')
          10,35 say 3.ID    : + t:trid
          if .not. (t:torrid = '      ')
            10,56 SAY or    : + t:torrid
          endif
          if .not. (t:urid = '      ')
              11,35 say 4.ID    : + t:urid
              if .not. (t:uorrid = '      ')
                11,56 SAY or    : + t:uorrid
              endif
```

```
                if .not. (t:irid = '      ')
                    12,35 say 5.ID   : + t:irid
                    if .not. (t:iorrid = '      ')
                      12,56 SAY or   : + t:iorrid
                    endif
                endif
            endif
        endif
     endif
  endif

*************
  store 14 to r

  20,20 SAY
  if (t:frid = '      ')
    use eletopre index eletopre
    append blank
    replace ELEID with t:id
    replace REQID with 'NONE'
  else
    use eletopre index eletopre
    append blank
    replace ELEID with t:id
    replace REQID with t:frid
    select primary
    use prereq index prereq
    find &t:frid
    if # = 0
      append blank
      replace ID with t:frid
      store t:frid to t:rid
      do found
    endif
****
    if .not. (t:forrid = '      ')
```

```
      use elective index elective
      find &t:id
      replace ORFLAG with 'Y'
      use 2ndset index 2ndset
      append blank
      replace ELEID with t:id
      replace REQID with t:forrid
      select primary
      use prereq index prereq
      find &t:forrid
      if # = 0
        append blank
        replace ID with t:forrid
        store t:forrid to t:rid
        do found
      endif
    endif
***
    if .not. (t:srid = '      ')
      use eletopre index eletopre
      append blank
      replace ELEID with t:id
      replace REQID with t:srid
      select primary
      use prereq index prereq
      find &t:srid
      if # = 0
        append blank
        replace ID with t:srid
        store t:srid to t:rid
        do found
      endif
***
      if .not. (t:sorrid = '      ')
        use elective index elective
```

```
        find &t:id
        replace ORFLAG with 'Y'
        use 2ndset index 2ndset
        append blank
        replace ELEID with t:id
        replace REQID with t:sorrid
        select primary
        use prereq index prereq
        find &t:sorrid
        if # = 0
          append blank
          replace ID with t:sorrid
          store t:sorrid to t:rid
          do found
        endif
      endif
***
      if .not. (t:trid = '      ')
        use eletopre index eletopre
        append blank
        replace ELEID with t:id
        replace REQID with t:trid
        select primary
        use prereq index prereq
        find &t:trid
        if # = 0
          append blank
          replace ID with t:trid
          store t:trid to t:rid
          do found
        endif
***
        if .not. (t:torrid = '      ')
          use elective index elective
          find &t:id
```

```
          replace ORFLAG with 'Y'
          use 2ndset index 2ndset
          append blank
          replace ELEID with t:id
          replace REQID with t:torrid
          select primary
          use prereq index prereq
          find &t:torrid
          if # = 0
            append blank
            replace ID with t:torrid
            store t:torrid to t:rid
            do found
          endif
        endif
***
        if .not. (t:urid = '      ')
          use eletopre index eletopre
          append blank
          replace ELEID with t:id
          replace REQID with t:urid
          select primary
          use prereq index prereq
          find &t:urid
          if # = 0
            append blank
            replace ID with t:urid
            store t:urid to t:rid
            do found
          endif
***
          if .not. (t:uorrid = '      ')
            use elective index elective
            find &t:id
            replace ORFLAG with 'Y'
```

```
            use 2ndset index 2ndset
            append blank
            replace ELEID with t:id
            replace REQID with t:uorrid
            select primary
            use prereq index prereq
            find &t:uorrid
            if # = 0
              append blank
              replace ID with t:uorrid
              store t:uorrid to t:rid
              do found
            endif
          endif
***
          if .not. (t:irid = '      ')
            use eletopre index eletopre
            append blank
            replace ELEID with t:id
            replace REQID with t:irid
            select primary
            use prereq index prereq
            find &t:irid
            if # = 0
              append blank
              replace ID with t:irid
              store t:irid to t:rid
              do found
            endif
***
            if .not. (t:iorrid = '      ')
              use elective index elective
              find &t:id
              replace ORFLAG with 'Y'
              use 2ndset index 2ndset
```

```
                append blank
                replace ELEID with t:id
                replace REQID with t:iorrid
                select primary
                use prereq index prereq
                find &t:iorrid
                if # = 0
                  append blank
                  replace ID with t:iorrid
                  store t:iorrid to t:rid
                  do found
                endif
              endif
            endif
          endif
        endif
      endif
    endif

enddo
*************************************************************************
***************************** FOUND.prg *********************************
*  Program name : found
*  Author       : R. Tanju SIRMEN
*  Date         : November 1985
*  Description  : This routine searches declared prerequisite courses
*                 of the new elective to see whether they are already
*                 in the data base as electives or prerequisites. If it
*                 is not so, asks for the data of this new prerequisite
*  Called by    : getpre.prg
*  Calles       : none
*  Input files  : elective.dbf, elective.ndx, prereq.dbf, prereq.ndx
*  Output files : prereq.dbf, prereq.ndx
*  Local        :t:rid,f:correct,f:mistake,t:pfflag,f:rtit,f:rcrh,f:pflg
*************************************************************************
```

```
 20,47 SAY
use elective index elective
find &t:rid
if # = 0
  use prereq index prereq
  find &t:rid
  store 'N' to f:correct
  do while f:correct = 'N'
     set color to 112,green
     r-1,31 say ____________________________________________________
     r , 34 SAY ID           :  + ID
     set color to 112,ccolor
     r+1,34 SAY Title        :
     r+3,40 say
     r+1,48 get TITLE picture '!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!'
     read
     clear gets
     set color to 112,mcolor
     20,47 SAY  Correct..(Y/N)?  + chr(7)
     set color to 112,ccolor
     20,65 GET f:correct picture '!'
     read
     do while .not. (f:correct = 'N' .or. f:correct = 'Y')
        do error
        20,65 GET f:correct picture '!'
        read
     enddo
     if f:correct = 'Y'
        set color to 112,mcolor
        r+3,40 say  I'll be right back...
        set color to 112,ccolor
     endif
  enddo
else * found in elective dbf
  store trim(title) to t:rtit
```

```
   use prereq index prereq
   find &t:rid
   replace TITLE with t:rtit
endif
release all like f:*
return
*************************************************************************
*************************** DEL.prg ***********************************
*  Program name : del
*  Author       : R. Tanju SIRMEN
*  Date         : November 1985
*  Description  : This routine is used to delete old electives from the
*                 data base
*  Called by    : maint.prg
*  Calles       : none
*  Input files  : elective.dbf, elective.ndx
*  Output files : elective.dbf,eletopre.dbf,elective.ndx,eletopre.ndx
*  Local        : answer,t:id,v:id,s:id,t:dlt
*************************************************************************

set talk off
set delete on
erase
store 'Y' to answer
set color to 112,green
 2,1 SAY ____________________________________________________________________
 2,56 SAY ________________________
set color to 112,hcolor
  4,30 SAY   DELETE OLD ELECTIVE
set color to 112,ccolor
 11,24 SAY  This program is used to delete old
 12,24 SAY  elective courses from the database
 13,27 SAY  Course ID will be asked you
set color to 112,green
 18,1 SAY ___________________________________________________________________
 18,56 SAY ________________________
```

```
set color to 112,mcolor
 23,25 SAY  Do you want to continue (Y/N)?  + chr(7)
set color to 112,ccolor
 23,57 GET answer picture '!'
read
do while .not. (answer = 'Y' .or. answer = 'N')
   do error
   23,57 GET answer picture '!'
   read
enddo
if (answer) = 'N'
   release answer
   return
endif

store 'Y' to another

do while another # 'N'

   store  '      ' to t:id
   erase
   set color to 112,mcolor
   10,20 SAY Enter the course's ID to be deleted + chr (7)
   set color to 112,ccolor
   10,55 GET t:id PICTURE !!9999
   12,25 SAY A Blank ID returns you back
   read
   if (t:id) = '      '
      erase
      release all like t:*
      release v:id,s:id
      return
   endif
   use elective index elective
   find &t:id
   if # = 0
      erase
```

```
   set color to 112,hcolor
   11,27 SAY  No course has the ID  + t:id
   set color to 112,ccolor
   13,25 SAY It may have already been deleted
   set color to 112,mcolor
   22,26 SAY  Press any key to continue... + chr(7)
   set console off
   wait
   set console on
else
   erase
   set color to 112,hcolor
   3,25 SAY  This is the course to be deleted
   set color to 112,green
   5,1 SAY ____________________________________________________________
   5,56 SAY ________________________
   set color to 112,ccolor
   7, 15 SAY ID           :  + ID
   9, 15 SAY Title        :  + TITLE
   11,15 SAY Credit Hours :  + CRHOURS
   13,15 SAY Pass/Fail    :
   if pfflag = '0'
       13,30 SAY NO
   else * pfflag = '1'
       13,30 SAY YES
   endif
   15,15 SAY Season       :  + SEASON
   set color to 112,green
   18,1 SAY ___________________________________________________________
   18,56 SAY ________________________
   store 'N' to t:dlt
   set color to 112,mcolor
   20,15 SAY  Do you still want to delete this course...(Y/N)?  + chr(7)
   set color to 112,ccolor
   20,65 GET t:dlt picture '!'
```

```
read
clear gets
do while .not. (t:dlt = 'Y' .or. t:dlt = 'N')
   do error
   20,65 GET t:dlt picture '!'
   read
enddo
if (t:dlt) = 'Y'
   delete
   ERASE
   set color to 112,hcolor
   10,20 SAY t:id +  has been DELETED from the database + chr(7)
   use eletopre index eletopre
   find &t:id
   store eleid to v:id
   if # <> 0
      do while t:id = v:id .and. .not. eof
         store eleid to v:id
         delete
         skip
      enddo
      use 2ndset index 2ndset
      find &t:id
      store eleid to s:id
      if # <> 0
         do while t:id = s:id .and. .not. eof
            store eleid to s:id
            delete
            skip
         enddo
      endif
   endif
else
   22,70 say '         '
   23,70 say '         '
```

```
      endif
   endif
   set color to 112,ccolor
   ? chr(7)
   set color to 112,mcolor
   22,25 SAY  Another Delete ...(Y/N) ?  get another picture '!'
   set color to 112,ccolor
   read
   do while .not. (another = 'Y' .or. another = 'N')
      do error
      22,52 GET another picture '!'
      read
   enddo
enddo

release all like t:*
release v:id,s:id
return

*****************************************************************************
**************************** EDIT.prg ***********************************
*  Program name : edit
*  Author       : R. Tanju SIRMEN
*  Date         : November 1985
*  Description  : This program allows the user to edit the contents
*                 of any elective course.
*  Called by    : maint.prg
*  Calles       : none
*  Input files  : elective.dbf, elective.ndx
*  Output files : same as input files
*  Local        :answer,e:anthr,e:id,t:date,e:correct,e:mistake,e:pfflag
*****************************************************************************
set talk off
erase
set color to 112,green
 2,1 SAY ____________________________________________________________
```

```
 2,56 SAY ________________________
set color to 112,hcolor
  4,32 SAY  EDIT AN ELECTIVE
set color to 112,ccolor
 10,25 SAY This program allows you to edit
 11,23 SAY the content of any elective course
 12,27 SAY Course ID will be asked you
set color to 112,green
 18,1 SAY ________________________________________________________
 18,56 SAY ________________________
set color to 112,mcolor
 23,25 SAY  Do you want to continue (Y/N)?  + chr(7)
set color to 112,ccolor
store 'Y' to answer
 23,57 GET answer picture '!'
read
do while .not. ((answer = Y) .or. (answer = N))
   do error
   set color to 112,ccolor
   23,57 get answer picture '!'
   read
enddo

if !(answer) = 'N'
   release answer
   return
endif

store 'Y' to e:anthr
do while e:anthr = 'Y'

   store  '      ' to e:id
   erase
   set color to 112,mcolor
   10,19 SAY  Enter the course's ID to be edited  + chr(7)
   set color to 112,ccolor
   10,55 GET e:id PICTURE !!9999
```

```
12,24 SAY A Blank ID returns you back
read
if (e:id) = '       '
    erase
    release all like e:*
    return
endif
use elective index elective
find &e:id
if # = 0
   erase
   set color to 112,hcolor
   11,27 SAY  No course has the ID  + e:id
   set color to 112,ccolor
   13,25 SAY It may have already been deleted
   set color to 112,mcolor
   20,26 SAY  Press any key to continue... + chr(7)
   set console off
   wait
   set console on
else
   erase
   store DATE() to t:date
   set color to 112,hcolor
   1,5 SAY  EDITING SCREEN FOR ELECTIVE COURSES
   1,60 SAY DATE:  + t:date
   set color to 112,green
   2,1 SAY ________________________________________________________________
   2,56 SAY _________________________
   store 'N' to correct
   do while correct = 'N'
      store t to e:mistake
      do while e:mistake
         set color to 112,ccolor
         7, 15 SAY ID           :: + e:id + :
```

```
9, 15 SAY Title        :
11,15 SAY Credit Hours :
13,15 SAY Pass/Fail    :
if pfflag = '0'
   store NO  to e:pfflag
else * pfflag = '1'
   store YES to e:pfflag
endif
15,15 SAY Season       :
9,29 get TITLE picture '!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!'
11,29 get CRHOURS picture '9.9'
13,29 get e:PFFLAG picture '!!!!'
15,29 get SEASON picture '!!!'
set color to 112,green
18,1 SAY ____________________________________________________________________
18,56 SAY ____________________
set color to 112,ccolor
20,20 SAY
read
clear gets
if .not. (e:pfflag = 'YES' .or. e:pfflag = 'NO ')
   do error
   set color to 112,acolor
   13,34 say '<<=='
   set color to 112,ccolor
   13,38 say ' YES/NO'
else
   store f to e:mistake
endif
do case
   case e:pfflag = 'NO '
   replace PFFLAG with '0'
otherwise * pfflag = 'YES'
   replace PFFLAG with '1'
endcase
```

```
         enddo
         13,34 say '              '
         22,70 SAY
         23,70 SAY
         set color to 112,mcolor
         20,21 SAY  Are all the entries correct...(Y/N)?  + chr(7)
         set color to 112,ccolor
         20,59 GET correct picture '!'
         read
         do while .not. (correct = 'N' .or. correct = 'Y')
            do error
            20,59 GET correct picture '!'
            read
         enddo
         22,70 SAY
         23,70 SAY
      enddo
   endif

   set color to 112,mcolor
   23,26 SAY  Edit another one...(Y/N)?  + chr(7)
   set color to 112,ccolor
   23,53 GET e:anthr picture '!'
   read
   do while .not. (e:anthr = 'N' .or. e:anthr = 'Y')
      do error
      23,53 GET e:anthr picture '!'
      read
   enddo
enddo

release all like e:*
return

*************************************************************************
************************** gimme.prg ***********************************
*  Program name : gimme
```

```
*  Author       : R. Tanju SIRMEN
*  Date         : November 1985
*  Description  : Gets some of the predictor variables about the user,
*                 (i.e. Language, etc.) to be used in the prediction
*                 formula in predict.prg
*  Called by    : tez.prg
*  Calles       : list.prg
*  Input files  : None
*  Output files : None
*  Local        : correct,r,lng,sex,rfs,rfv,lnv,flng,fsex,frfs,mistake
*************************************************************************

erase

store  9 to r
store 'Y' to lng
store 'M' to sex
store 'Y' to rfs

set color to 112,green
 3,1   SAY ____________________________________________________________
 3,56  SAY ________________________
 20,1  SAY ____________________________________________________________
 20,56 SAY ________________________

set color to 112,mcolor
 r,25 say  Is English Your Native Tone ?
 22,30 say    Y for yes
 23,30 say    N for no
set color to 112,ccolor
 r,56 get lng picture '!'
read

do while .not. (lng = 'Y' .or. lng = 'N')
   do error
   r,56 get lng picture '!'
   read
enddo
```

```
 22,70 say '          '
 23,70 say '          '

set color to 112,ccolor

do case
    case lng = 'Y'
       store Do    to lng
    case lng = 'N'
       store Don't to lng
endcase
 r,25 say
 r,25 say  You  + lng +  Speak English


set color to 112,mcolor
 r+2,25 say  Your Sex ?
 22,30 say  F for Female
 23,30 say   M for Male
set color to 112,ccolor
 r+2,38 get sex picture '!'
read

do while .not. (sex = 'M' .or. sex = 'F')
   do error
   r+2,38 get sex picture '!'
   read
enddo

 22,70 say '          '
 23,70 say '          '

set color to 112,ccolor

do case
    case sex = M
       store Male   to sex
    case sex = F
```

```
       store Female to sex
endcase
 r+2,25 say
 r+2,25 say  You are  + sex



set color to 112,mcolor
 r+4,25 say  Have You Taken Refresher ?
 22,30 say    Y for yes
 23,30 say    N for no
set color to 112,ccolor
 r+4,54 get rfs picture '!'
read

do while .not. (rfs = 'Y' .or. rfs = 'N')
   do error
   r+4,54 get rfs picture '!'
   read
enddo

 22,70 say '         '
 23,70 say '         '

set color to 112,ccolor

do case
    case rfs = 'Y'
       store Did    to rfs
    case rfs = 'N'
       store Didn't to rfs
endcase
 r+4,25 say
 r+4,25 say  You  + rfs +  Take Refresher

 22,30 say
 23,30 say

set exact on
```

```
store 'N' to correct
set color to 112,mcolor
 22,21 say  Are all the entries correct...(Y/N)?  + chr(7)
set color to 112,ccolor
 22,58 get correct picture '!'
read

do while .not. (correct = 'Y' .or. correct = 'N')
    do error
    22,58 get correct picture '!'
    read
enddo

do while correct = 'N'
   erase
   store 'T' to mistake

   set color to 112,green
   3,1   SAY ____________________________________________________________
   3,56  SAY _________________________
   20,1  SAY ____________________________________________________________
   20,56 SAY _________________________

   do while mistake = 'T'
      store 'F' to mistake
      22,20 say
      set color to 112,mcolor
      22,25 say .... Do the correction(s) .... + chr(7)
      set color to 112,ccolor
      r  ,10 say  You  get lng picture 'DO!!!'
      r  ,22 say  speak English
      set color to 112,Mcolor
(DO   /DON'T)
      set color to 112,Ccolor
      r+2,10 say  You are  get sex picture '!!!!!!'
      set color to 112,Mcolor
```

```
FEMALE]
      set color to 112,Ccolor
      r+4,10 say  You  get rfs picture 'DID!!!'
      r+4,23 say  Take Refresher
      set color to 112,Mcolor
DIDN'T]
       set color to 112,Ccolor
      read
      clear gets

      r  ,47 say
      r+2,47 say
      r+4,47 say
      22,70 say '          '
      23,70 say '          '

      store TRIM( (lng)) to lnv
      if .not. (lnv = DO .or. lnv = DON'T )
            do error
            set color to 112,acolor
            r  ,47 say ==>
            set color to 112,Ccolor
            store 'T' to mistake
      endif

      if .not. (sex = FEMALE .or. sex = MALE    )
            do error
            set color to 112,acolor
            r+2,47 say ==>
            set color to 112,Ccolor
            store 'T' to mistake
      endif

      store TRIM( (rfs)) to rfv
      if .not. (rfv = DIDN'T .or. rfv = DID )
            do error
            set color to 112,acolor
```

```
            r+4,47 say ==>
            set color to 112,Ccolor
            store 'T' to mistake
      endif

   enddo
   set color to 112,mcolor
   22,20 say  Are all the entries correct...(Y/N)?  + chr(7)
   set color to 112,ccolor
   22,58 get correct picture '!'
   read

   do while .not. (correct = 'Y' .or. correct = 'N')
       do error
       22,58 get correct picture '!'
       read
   enddo
enddo

store TRIM(!(lng)) to lnv
store TRIM(!(sex)) to sex
store TRIM(!(rfs)) to rfv

do case
   case lnv = DO
       store 0 to flng
   case lnv = DON'T
       store 1 to flng
endcase

do case
   case sex = MALE
       store 0 to fsex
   case sex = FEMALE
       store 1 to fsex
endcase

do case
```

```
   case rfv = DIDN'T
       store 0 to frfs
   case rfv = DID
       store 2 to frfs
endcase

set exact off

do list
*************************************************************************
************************** list.prg ************************************
*  Program name : list
*  Author       : R. Tanju SIRMEN
*  Date         : November 1985
*  Description  : Lists all the elective courses' Ids and titles
*  Called by    : gimme.prg
*  Calles       : prereq.prg
*  Input files  : None
*  Output files : None
*  Local        : r,c,max,any
*************************************************************************

do while t

   erase
   use elective index elective
   store 6 to r
   store 0 to c
   store 19 to max
   set color to 112,hcolor
   1,26 SAY  ELECTIVE COURSES LISTING
   4,1 SAY  ID
   4,13 SAY  TITLE
   4,41 SAY  ID
   4,53 SAY  TITLE
   set color to 112,ccolor
   do while .not. eof
```

```
    if r < max
        r,c SAY id
        r,(c + 8) SAY title
        store (r + 1) to r
        skip
    else
        store (40 + c) to c
        store 6 to r
    endif
     if c = 80 .and .not. eof
        store 6 to r
        store 0 to c
        set color to 112,mcolor
        23,21 SAY chr(7) +  Press any key to see the next page...
        set console off
        wait
        set console on
        erase
        set color to 112,hcolor
        1,26 SAY  ELECTIVE COURSES LISTING
        4,1 SAY  ID
        4,13 SAY  TITLE
        4,41 SAY  ID
        4,53 SAY  TITLE
        set color to 112,ccolor
     endif

enddo
store t to any
if any
    set color to 112,mcolor
    23,21 SAY chr(7) +  Press any key to continue...
    set console off
    wait
    set console on
    DO PREREQ
```

```
   endif

enddo

*************************************************************************
************************* prereq.prg ***********************************
*  Program name : prereq
*  Author       : R. Tanju SIRMEN
*  Date         : November 1985
*  Description  : Gets the elective course's Id that the user wants to be
*                 predicted. Gives prerequisite courses for that elective.
*  Called by    : list.prg
*  Calles       : grd.prg, predict.prg
*  Input files  : None
*  Output files : None
*  Local        : again,no:pre,cid,choice,ecid,r,count,rcid,t:or,
*                 t:orflag,avg,this
*************************************************************************

do while t

store t to again
store 'N' to no:pre
do while again
   erase
   set color to 112,green
   3,1   SAY ____________________________________________________________
   3,56  SAY ____________________________
   store '      ' to cid
   set color to 112,mcolor
   11,15 SAY  Enter the ID for the course to be predicted  ;
              get cid picture '!!9999'
   set color to 112,ccolor
   14,27 say A blank ID ends the process
   set color to 112,green
   20,1  SAY ____________________________________________________________
   20,56 SAY ____________________________
```

```
read
if cid = '       '
   release cid,again,count
   do quit
endif
store trim(!(cid)) to cid
use elective index elective
find &cid
if # = 0
   erase
   set color to 112,hcolor
   4,31 SAY  RECORD NOT FOUND
   set color to 112,green
   6,1   SAY ____________________________________________________________
   6,56  SAY ________________________
   set color to 112,ccolor
   10,26 SAY  cid +  is not in my database
   12,22 SAY  If you don't remember the correct ID
   14,19 SAY  enter L to get the elective courses listing
   16,24 SAY  Otherwise, enter A to try again
   set color to 112,green
   20,1  SAY ____________________________________________________________
   20,56 SAY ________________________
   set color to 112,mcolor
   store 'A' to choice
   23,28 SAY  ' Your choice.....(L/A)? ' + chr(7)
   set color to 112,ccolor
   23,52 get choice picture '!'
   read
   do while .not.(choice = 'L' .or. choice = 'A')
       do error
       23,52 get choice picture '!'
       read
   enddo
   if choice = 'L'
```

```
        release cid,choice,again,count
        ERASE
        return
    endif
else
    store 'Y' to this
    erase
    set color to 112,green
    3,1   SAY ____________________________________________________________
    3,56  SAY ________________________
    set color to 112,hcolor
    6,17 SAY  This is the data of the questioned course
    set color to 112,ccolor
    9, 23 SAY ID           :  + ID
    11,23 SAY Title        :  + TITLE
    13,23 SAY Credit Hours :  + CRHOURS
    15,23 SAY Pass/Fail    :
    if pfflag = '0'
       15,38 SAY NO
    else * pfflag = '1'
       15,38 SAY YES
    endif
    17,23 SAY Season       :  + SEASON
    set color to 112,green
    20,1  SAY ____________________________________________________________
    20,56 SAY ________________________
    set color to 112,mcolor
    22,13 SAY  Is this the course you want to be predicted...(Y/N)?
    set color to 112,ccolor
    ? chr(7)
    22,67 get this picture '!'
    read
    do while .not. (this = 'Y' .or. this = 'N')
       do error
       22,67 get this picture '!'
```

```
         read
      enddo
      if this = 'Y'
         store f to again
      endif
   endif
enddo
store orflag to t:or
set color to 112,hcolor
erase
 2,25 say ID + '  ' + title
 4,2 say ' Prerequisite Courses '
set color to 112,ccolor
store id to ecid
store 6 to r
store 0 to t:orflag
store 1 to count
select primary
use eletopre index eletopre
find &ecid
if reqid = 'NONE'
   r,5 say 'There is no prerequisite course for' + '  ' + ecid
   store 'Y' to no:pre
else
   if reqid = 'FINAL'
     r,5 say 'You should be in your final quarter to take' + '  ' + ecid
     store 'Y' to no:pre
   else
      do while (ecid = eleid .and. (.not. eof))
         store reqid to rcid
         select secondary
         use prereq index prereq
         find &rcid
         r,2 say id + '  ' + title
         store r+1 to r
```

```
         store count+1 to count
         select primary
         skip
      enddo
      if t:or = 'Y'
           store r to t:orflag
           store r+2 to r
           set color to 112,hcolor
           r-1,2 say    OR
           set color to 112,ccolor
           select primary
           use 2ndset index 2ndset
           find &ecid
           do while (ecid = eleid .and. (.not. eof))
             store reqid to rcid
             select secondary
             find &rcid
             store r+1 to r
             r,2 say id + '   ' + title
             store count+1 to count
             select primary
             skip
           enddo
      endif
   endif
endif
set color to 112,mcolor
 23,23 SAY chr(7) +  Press any key to continue...
set console off
wait
set console on

do case
   case no:pre = 'Y'
       store 3.5 to avg
       do predict
```

```
   case no:pre = 'N'
        do grd
endcase

enddo

*************************************************************************
************************** grd.prg ***************************************
*  Program name : grd
*  Author       : R. Tanju SIRMEN
*  Date         : November 1985
*  Description  : Gets the prerequised courses grades that the user has
*                 taken. Calculates the average point of prerequiseds.
*  Called by    : prereq.prg
*  Calles       : predict.prg
*  Input files  : None
*  Output files : None
*  Local        : r,c,count2,cumul,more,correct,avg,t:tot,grd
*************************************************************************

store 6 to r
store 1 to count2
store 42 to c
store 0.000 to cumul
store t to more
store 'N' to correct
store 0 to t:tot

 20,20 say   Give your grades as A, A-, B+,.., D+, D, F
 21,20 say   If you have not taken the course, enter  N
set color to 112,ccolor
 23,23 say

do while more
   do while count2 < count
      set color to 112,ccolor
      store '  ' to grd
      set color to 112,mcolor
```

```
r,c say  Your grade from this course...?
set color to 112,ccolor
r,76  get grd  picture '!!'
read
clear gets
r,c say             Your grade was           + grd
store count2+1 to count2
store t:tot+1 to t:tot
store r+1 to r

22,70 say '         '
23,70 say '         '

do case
    case grd = 'A '
        store 4.0 to grd
    case grd = 'A-'
        store 3.7 to grd
    case grd = 'B+'
        store 3.3 to grd
    case grd = 'B '
        store 3.0 to grd
    case grd = 'B-'
        store 2.7 to grd
    case grd = 'C+'
        store 2.3 to grd
    case grd = 'C '
        store 2.0 to grd
    case grd = 'C-'
        store 1.7 to grd
    case grd = 'D+'
        store 1.3 to grd
    case grd = 'D '
        store 1.0 to grd
    case grd = 'F '
        store 0.0 to grd
```

```
        case grd = 'N '
            store 0.0 to grd
            store (t:tot-1) to t:tot
        otherwise
            do error
            store count2-1 to count2
            store t:tot-1 to t:tot
            store r-1 to r
            store 0.0 to grd

    endcase

    store grd+cumul to cumul

     if r = t:orflag
         store r+3 to r
     endif

enddo
store 'Y' to correct
set color to 112,mcolor
18,20 say  Are all the entries correct......(Y/N) ?   + chr(7)
set color to 112,ccolor
18,63 get correct picture '!'
read

do while .not. (correct = 'Y' .or. correct = 'N')
    do error
    18,63 get correct picture '!'
    read
enddo

if correct = 'Y'
    store f to more
else
    store 0.000 to cumul
    store 6 to r
    store 1 to count2
```

```
        store 0 to t:tot
        store 'Y' to correct
    endif

    22,70 say '         '
    23,70 say '         '

enddo

if t:tot
 0
    store (cumul)/(t:tot) to avg
    do predict
else
    ? chr(7)
    ? chr(7)
    set color to 112,mcolor
    22,22 say  Too few courses taken. I cannot predict
    23,28 say  Press any key to continue...
    set console off
    wait
    set console off
    do another
endif
*************************************************************************
*************************** predict.prg *********************************
*  Program name : predict
*  Author       : R. Tanju SIRMEN
*  Date         : November 1985
*  Description  : Using the obtained predictors, and the formula,
*                 calculates the predicted success.
*  Called by    : grd.prg, prereq.prg
*  Calles       : another.prg
*  Input files  : None
*  Output files : None
*  Local        : predict,grade,print
*************************************************************************
```

```
erase

*** The prediction is made here
store ((0.7853*avg) - (0.28768*flng) + (0.15181*fsex) - (0.06427*frfs) ;
                          + 0.70699) to predict

set color to 112,hcolor

 8,35 say  For
 8,40 say ecid + chr(7)
set color to 112,rcolor
 10,22 say  Predicted QPR is
 10,46 say predict
set color to 112,acolor
 10,59 say '<=='
set color to 112,rcolor
 10,63 say ' '
do case
   case predict < 0.85
       store 'F' to grade
   case predict > 0.85 .and. predict < 1.15
       store 'D' to grade
   case predict > 1.15 .and. predict < 1.5
       store 'D+' to grade
   case predict > 1.5 .and. predict < 1.85
       store 'C-' to grade
   case predict > 1.85 .and. predict < 2.15
       store 'C' to grade
   case predict > 2.15 .and. predict < 2.50
       store 'C+' to grade
   case predict > 2.5 .and. predict < 2.85
       store 'B-' to grade
   case predict > 2.85 .and. predict < 3.15
       store 'B' to grade
   case predict > 3.15 .and. predict < 3.5
       store 'B+' to grade
```

```
   case predict > 3.5 .and. predict < 3.85
       store 'A-' to grade
   case predict > 3.85
       store 'A' to grade
endcase

 12,22 say  Predicted Grade is
 12,50 say grade
set color to 112,acolor
 12,59 say '<=='
set color to 112,rcolor
 12,63 say ' '

 14,22 say  Predicted Success is
 14,39 say (predict/4)*100
 14,55 say ' % '
set color to 112,acolor
 14,59 say '<=='
set color to 112,rcolor
 14,63 say ' '
store 'N' to print
set color to 112,mcolor
 22,21 say  Do you want the print out ...(Y/N)?  + chr(7)
set color to 112,ccolor
 22,58 get print picture '!'
read
do while .not. (print = 'N' .or. print = 'Y')
   do error
   set color to 112,ccolor
   22,58 get print picture '!'
   read
enddo
if print = 'Y'
   set color to 112,mcolor
   22,21 say  Set the printer ready Then press a key
   set color to 112,ccolor
```

```
   set console off
   wait
   22,21 say
   set console on
   poke 56728, 205, 5, 195
   set call to 56728
   call
endif

set color to 112,mcolor
 23,26 say  Press any key to continue... + chr(7)

release avg,predict,print,grade

set console off
wait
set console on

do another

*************************************************************************
***************************** ANOTHER.prg *******************************
*  Program name : another
*  Author       : R. Tanju SIRMEN
*  Date         : November 1985
*  Description  : This routine asks whether the user wants another
*                 elective course to be predicted.
*  Called by    : predict.prg
*  Calles       : quit.prg
*  Input files  : none
*  Output files : none
*  Local        : another
*************************************************************************
erase
store 'Y' to another
 10,22 say  Do you want to try another one...(Y/N)?
set color to 112,ccolor
 10,63 get another picture '!'
```

```
read

do while .not. (another = 'Y' .or. another = 'N')
   do error
   10,63 get another picture '!'
   read
enddo

if another = 'N'
   erase
   set color to 112,hcolor
    3,23 say  It was a pleasure working with you
   set color to 112,green
   5,1   SAY ____________________________________________________________________
   5,56  SAY ________________________
   set color to 112,ccolor
    7,35 say By the way...
    9,26 say Predictions can never be exact
   11,31 say I am sure you can do
   13,28 say much better than I predict
   15,20 say This is the thesis work of R.Tanju SIRMEN
   17,18 say If you have any questions, please contact with
   19,17 say Prof. R.T.SIVASANKARAN  or  Prof. N.SCHNEIDEWIND
   set color to 112,green
   21,1  SAY ____________________________________________________________________
   21,56 SAY ________________________
   set color to 112,mcolor
   23,27 say  Press any key to quit... + chr(7)

   set console off
   wait
   set console on

   do quit

endif

*************************************************************************
```

```
****************************** ERROR.PRG *********************************
*  Program Name : error
*  Author       : R.Tanju SIRMEN
*  Date         : November 1985
*  Credits      : Main code was provided by Prof. N.LYONS NPS Monterey CA
*  Description  : The error routine flashes a bad input message at
*                 the corner of the screen and beeps three times to
*                 let the user know that the last command was bad.
* Input files   : None
* Output files  : None
* Called by     : All of the routines
* Calles        : None
* Local         : None
******************************************************************************

set color to 112,errcolor
 22,70 SAY Bad Input
 23,70 SAY Try Again
 23,70 SAY chr(7)
 23,70 SAY chr(7)
set color to 112,ccolor
return

******************************************************************************

****************************** quit.prg **********************************
*  Program Name : quit
*  Author       : R.Tanju SIRMEN
*  Date         : November 1985
*  Credits      : Main code was provided by Prof. N.LYONS NPS Monterey CA
*  Description  : This program terminates processing and returns
*                 control to the operating system.
* Input files   : None
* Output files  : None
* Called by     : tez.prg,prereq.prg,predict.prg
* Calles        : None
```

```
* Local          : None
*************************************************************************
*** **
quit
*****
```

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